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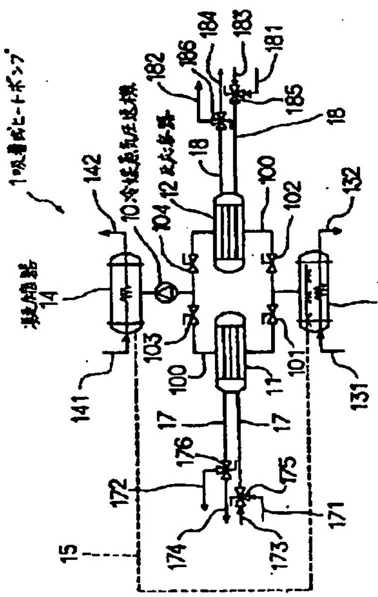
(54)【発明の名称】吸着式ヒートポンプ

(57)【要約】
【課題】　吸着行程で吸着材を冷却する冷却源がより高い温度で，再生行程で吸着材を加熱する加熱源がより低い温度である場合においても使用可能であり，装置体格の小型化が容易である，吸着式ヒートポンプを提供すること。
【解決手段】　冷媒蒸気を吸脱着可能な吸着材と，吸着材が充填され冷媒蒸気の吸脱着による反応熱を熱媒に伝達する反応容器１１，１２と，冷媒液の蒸発により得られた冷熱を外部へ取出す蒸発器１３と，冷媒蒸気の凝縮により得られた温熱を外部へ放熱する凝縮器１４と，冷媒蒸気の昇圧輸送を行う冷媒蒸気圧送機１０とからなり，該冷媒蒸気圧送機１０は再生行程にある上記反応容器１１，１２を減圧するよう構成されている。



【特許請求の範囲】

【請求項1】　冷媒蒸気を吸脱着可能な吸着材と，吸着材が充填され冷媒蒸気の吸脱着による反応熱を熱媒に伝達する反応容器と，冷媒液の蒸発により得られた冷熱を外部へ取出す蒸発器と，冷媒蒸気の凝縮により得られた温熱を外部へ放熱する凝縮器と，冷媒蒸気の昇圧輸送を行う冷媒蒸気圧送機とからなり，該冷媒蒸気圧送機は再生工程にある上記反応容器を減圧するよう構成されていることを特徴とする吸着式ヒートポンプ。

【請求項2】　冷媒蒸気を吸脱着可能で，かつ吸着特性がそれぞれ異なる２種類以上の吸着材と，同一温度条件で吸着平衡圧が低い吸着材と吸着平衡圧が高い吸着材とがそれぞれ充填され，かつ冷媒蒸気の吸脱着による反応熱を熱媒に伝達する反応容器と，冷媒液の蒸発により得られた冷熱を外部へ取出す蒸発器と，冷媒蒸気の凝縮により得られた温熱を外部へ放熱する凝縮器とからなり，吸着平衡圧が低い吸着材が充填された反応容器から，吸着平衡圧が高い吸着材が充填された反応容器へと冷媒蒸気を移送するよう構成されていることを特徴とする吸着式ヒートポンプ。

【発明の詳細な説明】

【０００１】

【技術分野】本発明は，冷凍機，冷蔵庫，空調装置等に利用可能な吸着式ヒートポンプに関する。

【０００２】

【従来技術】各種の冷凍機，冷蔵庫，空調装置等に利用されるような吸着式ヒートポンプは，冷媒蒸気を吸脱着可能な吸着材と，吸着材が充填され，冷媒蒸気の吸脱着が行われる反応容器と，冷媒液の蒸発により得られた冷熱を外部へ取り出す蒸発器と，冷媒蒸気の凝縮により得られた温熱を外部へ放出する凝縮器とがそれぞれ配管，バルブ等により相互に接続された構造を有している。

【０００３】上記吸着式ヒートポンプにおいて，冷媒蒸気は蒸発器から反応容器へ，また反応容器から凝縮器へと循環すると共に，反応容器は加熱源及び冷却源により交互に加熱または冷却され，該加熱または冷却に応じて反応容器中の吸着材が冷媒蒸気を吸着または脱着する。これが吸着または再生工程となる。

【０００４】吸着式ヒートポンプでは，一般に吸着行程における冷媒蒸気吸着量Ｘａと再生工程における冷媒蒸気吸着量Ｘｄとの差である吸脱着量差ΔＸ（＝Ｘａ－Ｘｄ）が熱出力源となる。冷媒蒸気吸着量は，吸着材の温度に対応した冷媒蒸気の飽和圧力Ｐｏと系内（例えば蒸発器）の冷媒蒸気の圧力Ｐとの比である相対蒸気圧Ｐ／Ｐｏにより決定される。

【０００５】吸着式ヒートポンプにおいてＸａは吸着行程にある吸着材温度が低いほど多くなり（Ｐ／Ｐｏが大である），Ｘｄは再生工程にある吸着材温度が高いほど少なくなる（Ｐ／Ｐｏが小である）が，Ｘａ＞Ｘｄでなければ吸着式ヒートポンプは機能しない。つまり，吸着材は加熱源及び冷却源により加熱または冷却されるため，吸着式ヒートポンプの作動には加熱源と冷却源との温度差がある程度大きいことが必要である。



【０００６】従来の吸着式ヒートポンプでは冷却源として低温の冷却水（３０℃以下）を用いて吸着行程の温度を下げることで，再生工程に必要な温度があまり高くならないようにしていた。これにより，再生工程の加熱源として低温の廃熱等を利用することができるようになった。または，加熱源として高温熱源（８０℃以上）を用いて再生工程の温度を上げることで，冷却塔で得られる温度（３０℃程度）以上に高温である冷却水を利用することができるようになった。

【０００７】

【解決しようとする課題】しかしながら，従来の吸着式ヒートポンプには次のような問題点がある。吸着式ヒートポンプにおいて，冷却塔等により得られる３０℃程度の冷却水を冷却源として利用した場合，１０℃の冷熱を得るためには７０℃以上の加熱源を必要とする。

【０００８】冷却塔を用いることが困難である一般家庭用及び自動車等の車載用エアコン等では，夏場（外気温度が３５℃程度となるような環境条件）に３０℃の低温冷却水を確保することは大変困難であった。更に，冷却水の温度が４０℃程度となった場合には，９５℃以上の高温の加熱源が必要となる。このような加熱源はボイラー等の加熱手段を用いないと実現できないという問題があった。このため，装置が大型化しやすく，家庭用，車載用の空調装置として利用することが困難であった。

【０００９】ところで，より低温の加熱源を用いて吸着式ヒートポンプの再生工程を実現する方法が特開平５－２４８７２７号で開示されている。ここでは蒸発器と凝縮器との間に２段の吸着塔（反応容器）を直列に接続して構成した吸着式ヒートポンプが開示されている。このヒートポンプは，１段目の吸着塔（反応容器）で吸着した冷媒蒸気を，再生工程が終了した２段目の吸着塔（反応容器）へ，１段目の脱着平衡圧と２段目の吸着平衡圧との差を利用して輸送することを特徴としている。

【００１０】上記吸着式ヒートポンプは３０℃程度の冷却水を冷却源として利用した場合，５０℃程度の加熱源を利用することにより１０℃の冷熱を得ることができる。また，上記従来技術においては，夏場における３０℃の冷却源はクーリングタワー（冷却塔）を利用し，５０℃の加熱源は工場や火力発電所等の排熱を利用することができるとしている。

【００１１】しかしながら，上記従来技術においても冷却塔等が必要であることから未だ車載用エアコン等の用途に提供する吸着式ヒートポンプとしては不充分である。更に，上記従来技術においては，冷却源となる冷却水温度が高い場合には，冷媒蒸気吸着量に対する平衡圧の変化が大きい領域で吸着式ヒートポンプが運転されるため，冷媒蒸気の吸脱着量差を十分確保するためには，

加熱源の温度を高くする必要があった。このため，例えば冷却源が３０℃となる条件下においては，加熱源を５０℃とすることができるが，冷却源を４０℃とした場合に同一性能を確保するためには，加熱源を８０℃以上とする必要があった。

【００１２】本発明は，かかる問題点に鑑み，吸着行程で吸着材を冷却する冷却源がより高い温度である場合においても，再生工程で吸着材を加熱する加熱源がより低い温度で使用可能であり，装置体格の小型化が容易である，吸着式ヒートポンプを提供しようとするものである。

【００１３】

【課題の解決手段】請求項１の発明は，冷媒蒸気を吸脱着可能な吸着材と，吸着材が充填され冷媒蒸気の吸脱着による反応熱を熱媒に伝達する反応容器と，冷媒液の蒸発により得られた冷熱を外部へ取出す蒸発器と，冷媒蒸気の凝縮により得られた温熱を外部へ放熱する凝縮器と，冷媒蒸気の昇圧輸送を行う冷媒蒸気圧送機とからなり，該冷媒蒸気圧送機は再生工程にある上記反応容器を減圧するよう構成されていることを特徴とする吸着式ヒートポンプにある。

【００１４】本発明の作用につき，以下に説明する。本発明においては，冷媒蒸気圧送機が再生工程にある反応容器を減圧するように構成されている。よって，反応容器からの冷媒蒸気の移動が可能となり，反応容器の再生工程をより促進することができる。

【００１５】このため，より低温の加熱源，より高温の冷却源を使用し，両者の温度差が小さく従来では吸着式ヒートポンプとして機能しないような場合であっても，本発明にかかる吸着式ヒートポンプは機能することができる。また，より低温の加熱源，より高温の冷却源を利用することができるため，冷却塔，ボイラー等の設備が不要となり，装置体格の小型化を図ることができる。更に，冷却塔，ボイラー等が不要であるため，一般家庭用，車載用エアコンとして利用することが可能となる。

【００１６】以上のように，本発明によれば，吸着行程で吸着材を冷却する冷却源がより高い温度で，再生工程で吸着材を加熱する加熱源がより低い温度である場合においても使用可能であり，装置体格の小型化が容易である，吸着式ヒートポンプを提供することができる。

【００１７】次に，吸着材を充填した反応容器を蒸発器と冷媒蒸気圧送機との間に対し２器以上配列することが好ましい（実施形態例２参照）。これにより，吸着材の平衡蒸気圧差を利用して反応容器間で冷媒蒸気の移動を行うことができる。これにより，脱着温度を更に低くすることができる。また，上記冷媒蒸気圧送機は２器の反応容器間に配設することもできる。

【００１８】次に，請求項２の発明は，冷媒蒸気を吸脱着可能で，かつ吸着特性がそれぞれ異なる２種類以上の吸着材と，同一温度条件で吸着平衡圧が低い吸着材と吸着平衡圧が高い吸着材とがそれぞれ充填され，かつ冷媒蒸気の吸脱着による反応熱を熱媒に伝達する反応容器と，冷媒液の蒸発により得られた冷熱を外部へ取出す蒸発器と，冷媒蒸気の凝縮により得られた温熱を外部へ放熱する凝縮器とからなり，吸着平衡圧が低い吸着材が充填された反応容器から，吸着平衡圧が高い吸着材が充填された反応容器へと冷媒蒸気を移送するよう構成されていることを特徴とする吸着式ヒートポンプにある（実施形態例３参照）。

【００１９】本請求項にかかる発明の作用につき，以下に説明する。本発明の吸着式ヒートポンプは，吸着平衡圧が低い吸着材を充填した反応容器，吸着平衡圧が高い吸着材を充填した反応容器とを有し，前者の反応容器から後者の反応容器へと冷媒蒸気を移送するよう構成されている。よって，吸着平衡圧の低い吸着材により高温での吸着が容易となり，吸着平衡圧の高い吸着材により低温での再生が容易となると共に，低圧吸着材の再生工程及び高圧吸着材の吸着工程をより促進することができる。

【００２０】このため，より低温の加熱源，より高温の冷却源を使用し，両者の温度差が小さく従来では吸着式ヒートポンプとして機能しないような場合であっても，本発明にかかる吸着式ヒートポンプは機能することができる。また，より低温の加熱源，より高温の冷却源を利用することができるため，冷却塔，ボイラー等の設備が不要となり，装置体格の小型化を図ることができる。更に，冷却塔，ボイラー等が不要であるため，一般家庭用，車載用エアコンとして利用することが可能となる。さらに２種類以上の吸着材を用いることで利用可能な反応領域（冷媒蒸気の吸脱着量差）を大幅に拡大できる。

【００２１】以上のように，本発明によれば，吸着行程で吸着材を冷却する冷却源がより高い温度で，再生工程で吸着材を加熱する加熱源がより低い温度である場合においても使用可能であり，装置体格の小型化が容易である，吸着式ヒートポンプを提供することができる。

【００２２】次に，冷媒蒸気を吸脱着可能で，同一温度条件で吸着平衡圧が低い吸着材と吸着平衡圧が高い吸着材とがそれぞれ充填され，かつ冷媒蒸気の吸脱着による反応熱を熱媒に伝達する反応容器と，冷媒液の蒸発により得られた冷熱を外部へ取出す蒸発器と，冷媒蒸気の凝縮により得られた温熱を外部へ放熱すると凝縮器と，冷媒蒸気の昇圧輸送を行う冷媒蒸気圧送機とからなり，吸着平衡圧が低い吸着材が充填された反応容器から，吸着平衡圧が高い吸着材が充填された反応容器へと冷媒蒸気を移送するよう構成されていることが好ましい（実施形態例４参照）。

【００２３】この場合，冷媒蒸気圧送機が再生工程にある反応容器を減圧するように構成されているため，反応容器からの冷媒蒸気の移動が可能となり，反応容器の再生工程をより促進することができる。また，同一温度条

件で吸着平衡圧の低い吸着材と吸着平衡圧の高い吸着材を組み合わせることで，吸着行程における吸着材温度が高い場合でも容易に冷媒蒸気を吸着でき，かつ再生工程においても高温熱源を必要とせず，さらに２種類以上の吸着材を用いることで利用可能な反応領域（冷媒蒸気の吸脱着量差）を大幅に拡大できる。

【００２４】

【発明の実施の形態】実施形態例１

本発明の実施形態例にかかる吸着式ヒートポンプにつき，図１～図３を用いて説明する。図１に示すごとく，本例の吸着式ヒートポンプ１は，冷媒蒸気を吸脱着可能な吸着材と，吸着材が充填され冷媒蒸気の吸脱着による反応熱を熱媒に伝達する反応容器１１，１２と，冷媒液の蒸発により得られた冷熱を外部へ取出す蒸発器１３と，冷媒蒸気の凝縮により得られた温熱を外部へ放熱する凝縮器１４と，冷媒蒸気の昇圧輸送を行う冷媒蒸気圧送機１０とからなり，該冷媒蒸気圧送機１０は再生工程にある上記反応容器１１，１２を減圧するよう構成されている。

【００２５】次に，本例にかかる吸着式ヒートポンプ１について詳細に説明する。図１に示すごとく，吸着材が充填された反応容器１１及び１２は冷媒蒸気配管１００により相互に接続され，該冷媒蒸気配管１００には制御バルブ１０１～１０４が設けてある。

【００２６】また，冷媒蒸気配管１００には蒸発器１３が接続されている。また，冷媒蒸気配管１００には冷媒蒸気圧送機１０を介して凝縮器１４が接続されている。また，反応容器１１及び１２は蒸発器１３，凝縮器１４の間に並列に接続されている。また，凝縮器１４と蒸発器１３との間には凝縮器にて凝縮された冷媒液を蒸発器１３に戻すための戻し配管１５が設けてある。なお，符号１３１は蒸発器１３からの冷房出力となる冷水の入口，符号１４１は凝縮器１４に対する冷却水の入口である。符号１３２，１４２は冷水，冷却水それぞれの出口である。また，冷水配管１３１，１３２には図示しない室内空間（空調空間）と熱交換可能に配設された室内機と，冷水を循環するポンプが接続されている。

【００２７】また，反応容器１１には熱媒配管１７が，反応容器１２には熱媒配管１８がそれぞれ接続され，該熱媒配管１７，１８には切り替えバルブ１７５，１７６及び１８５，１８６が設けてある。また，熱媒配管１７，１８は反応容器１１，１２内の吸着材を加熱または冷却するための加熱源または冷却源となる熱媒が流通している。本例の熱媒は温水（７０℃）及び冷却水（４０℃）である。

【００２８】温水は切り替えバルブ１７５，１７６，１８５，１８６の開閉により，入口１７３，１８３より導入され，各反応容器１１，１２を通過し，出口１７４，１８４より導出される。冷却水も同様の切り替えバルブ１７５，１７６，１８５，１８６の開閉により，入口１７１，１８１より導入され，各反応容器１１，１２を通過し，出口１７２，１８２より導出される。また，熱媒配管１７，１８には図示しない外気と熱交換可能に配設された室外機，温水を発生する温水器，熱媒を循環するポンプが接続されている。

【００２９】上記反応容器１１，１２には吸着材であるシリカゲルが充填されている。また，本例にかかる冷媒液，冷媒蒸気としては純水を使用した。また，反応容器１１，１２に対する加熱源及び冷却源として作用する熱媒としては通常の水道水（またはブライン［不凍液］）を利用した。なお，上記シリカゲルの水蒸気吸着量と，吸着材の温度に対応した水蒸気の飽和圧力Ｐｏと反応容器での水蒸気の圧力Ｐとの比である相対蒸気圧Ｐ／Ｐｏとの間の関係を図３に記載した。

【００３０】本例にかかる吸着式ヒートポンプ１の作動について説明する。第１行程では制御バルブ１０１，１０４を閉鎖，制御バルブ１０２，１０３を開放し，反応容器１１において再生工程を，反応容器１２において吸着行程を行った。また，この時切り替えバルブ１７５，１７６，１８５，１８６を操作し，熱媒パイプ１７には温水を，熱媒パイプ１８には冷却水を流通させた。

【００３１】反応容器１２は外気と熱交換して冷やされた冷却水により４０℃程度に冷却されている。また，制御バルブ１０２の開操作により蒸発器１３内の水は蒸発し，水蒸気となって反応容器１２に流れ込み，吸着材に吸着される。蒸発温度での飽和蒸気圧と吸着材温度４０℃に対応した吸着平衡圧との差により水蒸気移動が行われ，蒸発器１３においては蒸発温度に対応した冷熱，即ち冷房出力が得られる。蒸発器１３を流れる冷水が冷房出力となるため，この冷水が冷却されるには入口冷水温度よりも低い蒸発温度が必要である。この時の温度が蒸発温度であり，本例においては蒸発温度１０℃で運転操作を行った。

【００３２】再生工程にある反応容器１１は７０℃の温水により加熱され，７０℃に対応した脱着平衡圧となるが，凝縮器１４の凝縮温度４０℃（これは凝縮器を冷却している冷却水の温度に略等しい）での飽和蒸気圧が７０℃での脱着平衡圧より高いため，このままでは水蒸気の移動は行われない。

【００３３】そこで，上記制御バルブ１０４の開操作と平行して冷媒蒸気圧送機１０を運転する。冷媒蒸気圧送機１０は反応容器１１から吸い込んだ水蒸気を昇圧して凝縮温度４０℃での飽和蒸気圧以上とすることができる。反応容器１１から凝縮器１４へ水蒸気の移動が可能となり，反応容器１１の再生工程が行われる。凝縮器１４で水蒸気は凝縮され水となる。水は戻し管１５により蒸発器１３へ戻される。以上が第１行程である。

【００３４】次の第２行程においては，反応容器１１が吸着行程，反応容器１２が再生工程となるように，制御バルブ１０１～１０４及び切り替えバルブ１７５，１８

5，176，186を切り替えることで，同様に蒸発器13から冷熱，即ち冷房出力を得ることができる。以上の第1及び第2行程を順次切り替えることで吸着式ヒートポンプ1の連続運転を行った。

【0035】次に，吸着式ヒートポンプ1のサイクル図と共に作動状態を説明する。図2には温度40℃，70℃，95℃における水蒸気圧と水蒸気吸着量との関係を示した吸着材平衡圧の線が記載されている。また，同図における（4）’の圧力は温度40℃における水の飽和蒸気圧と等しい。同図において実線にて記載された（1）→（2）→（3）→（4）にかかるサイクルが本例にかかる吸着式ヒートポンプである。

【0036】前工程で脱着が終わった反応容器12は（4）の状態にあり，吸着行程への切り替えに先立ち，冷却水により（1）の状態まで冷却される。制御バルブ102の開操作により蒸発器13から水蒸気吸着を開始し（2）へ吸着量が増加する。前工程で吸着が完了した反応容器11は（2）の状態にあり，再生工程への切り替えに先立ち，温水により（3）の状態まで昇温される。制御バルブ103の開操作及び冷媒蒸気圧送機10の運転により反応容器11は（4）で得られる吸着材平衡圧程度に減圧され（4）の状態まで吸着量が減少し脱着が完了する。水蒸気は冷媒蒸気圧送機により（4）から（5）まで昇圧されて凝縮器14へ送られる。ここで凝縮して水となる。この水は戻し管15によって蒸発器13に戻される。

【0037】また，図2には本例にかかる吸着式ヒートポンプと全く同じ構造であるが，冷媒蒸気圧送機を持たない従来構造のもののサイクルを破線で記載した。このサイクルは（1）→（2）→（3）’→（4）’である。同図より知れるごとく，本例にかかる吸着式ヒートポンプ1と同様に吸着行程における吸着材を40℃，蒸発温度10℃で運転操作を行い，更に本例にかかるものと同様の性能（水蒸気吸脱着量差）を従来構造のヒートポンプより得るためには，再生工程における吸着材を95℃以上に保持しなければならないことが分かった。

【0038】吸着材を95℃以上に保持するための加熱源となる温水は実用上容易に得られるものではなく，ボイラー等の設備が必要である。従って，低温の冷却水が得られない条件下では，従来構造の吸着式ヒートポンプは運転そのものが困難であった。

【0039】次に，本例における作用効果につき説明する。本例にかかる吸着式ヒートポンプは冷媒蒸気圧送機10を有し，該冷媒蒸気圧送機10は反応容器11及び12から吸い込んだ水蒸気を昇圧して凝縮温度40℃での飽和蒸気圧以上とすることができる。反応容器11及び12から凝縮器14へ水蒸気の移動が可能となり，反応容器11及び12の再生工程が行われる。これにより，吸着行程における吸着材を40℃に冷却し，蒸発温度10℃で運転操作を行った場合，再生工程における吸着材が70℃程度であっても吸着式ヒートポンプを運転することができる。

【0040】このため，低温の冷却水または高温の温水を得るための冷却塔またはボイラー等の設置が不要となり，設備費及びランニングコストを大きく低減することができる。また，冷却塔やボイラー等の設置が不要であることから，小型でコンパクトな装置とすることができ，家庭用，車載用等限られた狭いスペースに設置可能な装置とすることができる。

【0041】従って，本例によれば，吸着行程で吸着材を冷却する冷却源がより高い温度で，再生工程で吸着材を加熱する加熱源がより低い温度である場合においても使用可能であり，装置体格の小型化が容易である，吸着式ヒートポンプを提供することができる。

【0042】なお，本例では，反応容器11，12の減圧操作を冷媒蒸気圧送機10の圧縮比（吐出圧／吸込圧）で3倍以下になるようにしたが，冷媒蒸気圧送機10の大型化や消費動力の増大が問題とならない使用条件下では，吸込圧を下げることでさらに低温での再生も可能となる。

【0043】実施形態例2
本例の吸着式ヒートポンプにつき図4，図5を用いて説明する。図4に示すごとく，本例にかかる吸着式ヒートポンプ2は実施形態例1の図1にかかるものと同様の構成を有している。但し，冷媒蒸気圧送機10と蒸発器13との間には2器づつ直列に配置した反応容器211，212，221，222を設けてある。

【0044】本例にかかる吸着式ヒートポンプ2の作動について説明する。第1行程では制御バルブ202，204，206を閉鎖，制御バルブ201，203，205を開放し，反応容器212，221において再生工程を，反応容器211，222において吸着行程を行った。また，この時切り替えバルブ175，176，185，186を操作し，熱媒パイプ17には60℃の温水を，熱媒パイプ18には40℃の冷却水を流通させた。

【0045】反応容器211は外気と熱交換して冷やされた冷却水により40℃程度に冷却されている。また，制御バルブ201の開操作により蒸発器13内の水は蒸発し，水蒸気となって反応容器211に流れ込み，吸着材に吸着される。蒸発温度での飽和蒸気圧と吸着材温度40℃に対応した吸着平衡圧との差により水蒸気移動が行われ，蒸発器13においては蒸発温度に対応した冷熱，即ち冷房出力が得られる。蒸発器13を流れる冷水が冷房出力となるため，この冷水が冷却されるには入口冷水温度よりも低い蒸発温度が必要である。本例においては蒸発温度10℃で運転操作を行った。

【0046】また，反応容器212，221は熱媒パイプ17に導入された60℃の温水によって加熱され，反応容器内の吸着材から水蒸気が脱離する。反応容器221からの水蒸気は開放された制御バルブ203を経出し

て反応容器２２２に流れ込み，該反応容器２２２は熱媒パイプ１８に導入された４０℃の熱媒にて４０℃に保持されている。このため，水蒸気の吸着が行われる。そして，反応容器２１２から脱離した水蒸気は開放された制御バルブ２０５を経て凝縮器１４に流れ込む。ここで水蒸気は冷却されて水となるが，この水は戻し管１５によって蒸発器１３に戻される。

【００４７】上述した反応容器２２１，２２２の間の水蒸気移動は，６０℃の脱着平衡圧と４０℃の吸着平衡圧との圧力差により行われる。また，反応容器２１２から凝縮器１４への水蒸気移動は，実施形態例１と同様に制御バルブ２０５の開操作と平行して冷媒蒸気圧送機１０を運転することにより行われる。

【００４８】次の第２行程においては，反応容器２１２，２２１が吸着行程，反応容器２１１，２２２が再生工程となるように，制御バルブ２０１～２０６及び切り替えバルブ１７５，１８５，１７６，１８６を切り替える。これにより同様に蒸発器１３から冷熱を得ることができる。以上の第１及び第２行程を順次切り替えることで吸着式ヒートポンプ２の連続運転を行った。その他は実施形態例１と同様である。

【００４９】なお，本例においては，７０℃以上の高温の温水が得られる運転条件においては，バイパス弁２９を開き，冷媒蒸気圧送機１０の運転を停止し，反応容器２２２から直接凝縮器１４への水蒸気移動もできるように構成されている。この場合には，冷媒蒸気圧送機１０の消費電力を低減することができる。

【００５０】次に，吸着式ヒートポンプ２のサイクル図と共に作動状態を説明する。図５には温度４０℃，６０℃における水蒸気圧と水蒸気吸着量との関係を示した吸着材平衡圧の線が記載されている。また，同図における（９）の圧力は温度４０℃における水の飽和蒸気圧と等しい。同図に示された二つのサイクルのうち，白丸は蒸発器１３側の反応容器２１１，２２１のサイクル，黒丸は反応容器２１２，２２２のサイクルを示している。また，反応容器２２１の吸着行程（４）→（１）→（２）は，実施形態例１と同様である。

【００５１】前行程で吸着が完了した反応容器２１１は（２）の状態にあり，再生工程への切り替えに先立ち温水により（３）まで昇温される。一方，前行程で脱着が完了した反応容器２１２は（８）の状態にあり，吸着行程への切り替えに先立ち冷却水により（５）まで冷却される。

【００５２】制御バルブ２０６の開操作を行うことで（３）と（５）との圧力差による水蒸気移動（図５における矢線）が行われ，反応容器２１１の吸着材は（３）から（４）へと吸着量が減少し（脱着され），反応容器２１２の吸着材は（５）から（６）へと吸着量が増加して吸着完了となる。

【００５３】前行程で吸着が完了した反応容器２２２は，実施形態例１と同様の操作により（６）→（７）→（８）と再生され，水蒸気は（８）から（９）に昇圧され凝縮器１４へ送られる。その他は実施形態例１と同様である。

【００５４】本例の吸着式ヒートポンプ２は冷却水が４０℃という高い温度で運転できることから，例えば，一般家庭用のエアコンや自動車用エアコンのように冷却塔を使用しない環境下でも利用可能となる。極めて実用価値の高いシステムを提供できる。更に，６０℃の温水は，自動車においてはエンジン冷却水を流用することができるし，温水暖房や温水床暖房を備えた家庭においてはこれらの装置より流用することができる。

【００５５】実施形態例３

本例は図６，図７に示すごとく，実施形態例２の図４にかかる構造の吸着式ヒートポンプであって，冷媒蒸気圧送機を使用しない構成としたものである。但し，二つの反応容器のそれぞれには図６に示すごとく特性の異なる吸着材を充填した。つまり，上記反応容器の一方（図４にかかる符号２１１，２２１にかかる反応容器）には，図６の実線Ａに示すような吸着平衡圧の低い吸着材Ａを充填する。もう一方（図４にかかる符号２１２，２２２にかかる反応容器）には，図６の実線Ｂに示すような吸着平衡圧の高い吸着材Ｂを充填する。

【００５６】本例の吸着材としては，特開平９－１７８２９２で開示されているメソポーラスモレキユラーシーブ（ＦＳＭ）などが好適であり，本例は上記ＦＳＭを使用温度域に合わせ一部改良して使用した。

【００５７】本例の吸着式ヒートポンプの運転操作は実施形態例２と同様に行うことができる。以下にその詳細について説明するが，この説明にかかる符号は図４に準じるものである。即ち，第１行程では制御バルブ２０２，２０４，２０６を閉鎖，制御バルブ２０１，２０３，２０５を開放し，反応容器２１２，２２１において再生工程を，反応容器２１１，２２２において吸着行程を行った。また，この時に切り替えバルブ１７５，１７６，１８５，１８６を操作し，熱媒パイプ１７に７０℃の温水を，熱媒パイプ１８に４０℃の冷却水を流通させた。

【００５８】反応容器２１１は外気と熱交換して冷やされた冷却水により４０℃程度に冷却されている。また，制御バルブ２０１の開操作により蒸発器１３内の水が蒸発し，水蒸気となって反応容器２１１に流れ込み，吸着材に吸着される。蒸発温度での飽和蒸気圧と吸着材温度４０℃に対応した吸着平衡圧との差により水蒸気移動が行われ，蒸発器１３においては蒸発温度に対応した冷熱，即ち冷房出力が得られる。蒸発器１３を流れる冷水が冷房出力となるため，この冷水が冷却されるには入口冷水温度よりも低い蒸発温度が必要である。本例においては蒸発温度１０℃で運転操作を行った。

【００５９】また，反応容器２１２，２２１は熱媒パイ

プ１７に導入された７０℃の温水によって加熱され，反応容器２１２，２２１内の吸着材から水蒸気が脱離する。反応容器２２１からの水蒸気は開放された制御バルブ２０３を経由して反応容器２２２に流れ込む。反応容器２２２は熱媒パイプ１８に導入された熱媒にて４０℃に保持されている。このため，水蒸気の吸着が行われる。反応容器２１２から脱離した水蒸気は開放された制御バルブ２０５を経て凝縮器１４に流れ込む。ここで水蒸気は冷却されて水となるが，この水は戻し管１５によって蒸発器１３に戻される。

【００６０】また，上述した反応容器２２１，２２２の間の水蒸気移動は，７０℃の脱着平衡圧（反応容器２２１）と４０℃の吸着平衡圧（反応容器２２２）との圧力差により行われる。また，反応容器２１２から凝縮器１４への水蒸気移動は，７０℃の脱着平衡圧（反応容器２１２）が水蒸気の凝縮温度４０℃に対応する飽和蒸気圧以上であることから，直接凝縮器１４に対して水蒸気移動を行っている。

【００６１】次の第２行程においては，反応容器２１２，２２１が吸着行程，反応容器２１１，２２２が再生工程となるように，制御バルブ２０１～２０６及び切り替えバルブ１７５，１８５，１７６，１８６を切り替える。これにより同様に蒸発器１３から冷熱を得ることができる。以上の第１及び第２行程を順次切り替えることで吸着式ヒートポンプ２の連続運転を行った。その他は実施形態例１と同様である。

【００６２】本例にかかる吸着式ヒートポンプでは，反応容器の一方に吸着平衡圧の低い吸着材Ａを用いることで，冷却水温度が高い条件下でも比較的多くの水蒸気を吸着できる。また，他方の反応容器に吸着平衡圧の高い吸着材Ｂを用いることで，比較的低い温度で水蒸気を脱着することができる。また，吸着材Ａと吸着材Ｂとは，反応容器間の水蒸気移動も考慮して選定する必要があるが，同一吸着材を用いる従来技術に比べて異なる吸着平衡圧の吸着材を組み合わせて使用していることから，反応容器間の水蒸気移動も容易に行うことができる。

【００６３】図７は本例にかかる吸着式ヒートポンプのサイクル図である。なお，図７には各吸着材Ａ及びＢの温度４０℃，７０℃における水蒸気圧と水蒸気吸着量との関係を示した吸着材平衡圧の線が記載されている。これを図８の従来技術によるサイクル図と比較した。

【００６４】図８にかかる吸着式ヒートポンプの構造は本例にかかる吸着式ヒートポンプと全く同じである。但し，反応容器には同一の吸着材を充填してある。このため，冷却水の温度が４０℃といった高い場合において，７０℃以上の温水を使用しないと水蒸気吸脱着量差を確保することができず，システムが成立しなかったため，再生温度７０℃で比較した。

【００６５】その結果，従来技術では同一吸着材を用いたため，水蒸気吸脱着量差を０．０４ｇ／ｇしか確保することができなかった。なお，水蒸気吸脱着量差は同図における（１）－（２）間，あるいは（５）－（６）の差［横軸方向］から読み取れる。

【００６６】しかしながら，本例のように異なる吸着材を使用することで，同一評価条件において水蒸気吸脱着量差を約０．１３ｇ／ｇを確保できた。即ち，従来技術の３倍強という非常に大きな値を得ることができた。したがって，図８の従来技術にかかる吸着式ヒートポンプと比較して１／３の量の吸着材で同じ性能を確保できることになり，装置全体の小型化を可能とすることができることが分かった。

【００６７】以上により，本例によれば小型で高性能な吸着式ヒートポンプを実現できることから，設置場所等に制約がある一般家庭用のエアコンや自動車用エアコンとしての適用が極めて容易な吸着式ヒートポンプを提供できる。

【００６８】実施形態例４

本例は図９に示すごとく実施形態例２にかかる吸着式ヒートポンプに対し，実施形態例３に記載の吸着平衡圧の低い吸着材Ａと吸着平衡圧の高い吸着材Ｂを充填した吸着式ヒートポンプである。そして，前述の図４にかかる反応容器２１１，２２１に吸着材Ａが，反応容器２１２，２２２に吸着材Ｂが充填されている。その他は実施形態例２と同様である。

【００６９】また運転操作等も実施形態例２と同様であるが，以下に詳細を説明する。なお，以下の説明において符号は実施形態例２の図４に準じるものである。第１行程では制御バルブ２０２，２０４，２０６を閉鎖，制御バルブ２０１，２０３，２０５を開放し，反応容器２１２，２２１において再生工程を，反応容器２１１，２２２において吸着行程を行った。また，この時切り替えバルブ１７５，１７６，１８５，１８６を操作し，熱媒パイプ１７には６０℃の温水を，熱媒パイプ１８には４０℃の冷却水を流通させた。

【００７０】反応容器２１１は外気と熱交換して冷やされた冷却水により４０℃程度に冷却されている。また，制御バルブ２０１の開操作により蒸発器１３内の水は蒸発し，水蒸気となって反応容器２１１に流れ込み，吸着材に吸着される。蒸発温度での飽和蒸気圧と吸着材温度４０℃に対応した吸着平衡圧との差により水蒸気移動が行われ，蒸発器１３においては蒸発温度に対応した冷熱，即ち冷房出力が得られる。蒸発器１３を流れる冷水が冷房出力となるため，この冷水が冷却されるには入口冷水温度よりも低い蒸発温度が必要である。本例においては蒸発温度１０℃で運転操作を行った。

【００７１】また，反応容器２１２，２２１は熱媒パイプ１７に導入された６０℃の温水によって加熱され，容器内の吸着材から水蒸気が脱離する。反応容器２２１からの水蒸気は開放された制御バルブ２０３を経由して反応容器２２２に流れ込み，該反応容器２２２は熱媒パイ

プ１８に導入された４０℃の熱媒にて４０℃に保持されている。この反応容器２２２では水蒸気の吸着が行われる。反応容器２１２から脱離した水蒸気は開放された制御バルブ２０５を経て凝縮器１４に流れ込む。ここで水蒸気は冷却されて水となるが，この水は戻し管１５によって蒸発器１３に戻される。

【００７２】また，上述した反応容器２２１，２２２の間の水蒸気移動は，６０℃の脱着平衡圧（反応容器２２１）と４０℃の吸着平衡圧（反応容器２２２）との圧力差により行われる。また，反応容器２１２から凝縮器１４への水蒸気移動は，実施形態例１と同様に制御バルブ２０５の開操作と平行して冷媒蒸気圧送機１０を運転することにより行われる。

【００７３】次の第２行程においては，反応容器２１２，２２１が吸着行程，反応容器２１１，２２２が再生工程となるように，制御バルブ２０１～２０６及び切り替えバルブ１７５，１８５，１７６，１８６を切り替える。これにより同様に蒸発器１３から冷熱を得ることができる。以上の第１及び第２行程を順次切り替えることで吸着式ヒートポンプ２の連続運転を行った。その他は実施形態例１と同様である。

【００７４】図９は本例にかかる吸着式ヒートポンプのサイクル図である。なお，図９には各吸着材Ａ，Ｂの温度４０℃，６０℃における水蒸気圧と水蒸気吸着量との関係を示した吸着材平衡圧の線が記載されている。なお，サイクルの詳細は実施形態例２と同様である。同図によれば，実施形態例３と同様に充分な量の水蒸気吸脱着差を確保しつつ，より低い温度の温水を利用することができる。よって，本例によれば６０℃の温水で大幅な吸脱着量差が得られるような性能の高い吸着式ヒートポンプを得ることができる。

【００７５】なお，本例では，冷媒蒸気圧送機の圧縮比を２倍以下として運転しており，より消費動力の低減を図ることができる。また，冷媒蒸気圧送機の圧縮比をより大きくして運転した場合には，温水の温度が更に低くとも吸着式ヒートポンプとしての運転を可能とすること



ができる。以上より，本例の吸着式ヒートポンプは一般家庭等の空調装置として適用することができる。このように，本例によれば吸着式ヒートポンプの応用先を格段に広げることができる。

【００７６】

【発明の効果】上記のごとく，本発明によれば，吸着行程で吸着材を冷却する冷却源がより高い温度で，再生工程で吸着材を加熱する加熱源がより低い温度である場合においても使用可能であり，装置体格の小型化が容易である，吸着式ヒートポンプを提供することができる。

【図面の簡単な説明】

【図１】実施形態例１にかかる，吸着式ヒートポンプのシステム構成を示す説明図。

【図２】実施形態例１にかかる，吸着式ヒートポンプのシステムの動作状態を示すサイクル図。

【図３】実施形態例１にかかる，反応容器に充填した吸着材の特性を示す吸着等温線図。

【図４】実施形態例２にかかる，吸着式ヒートポンプのシステム構成を示す説明図。

【図５】実施形態例２にかかる，吸着式ヒートポンプのシステムの動作状態を示すサイクル図。

【図６】実施形態例３にかかる，２種類の吸着材の特性を示す吸着等温線図。

【図７】実施形態例３にかかる，吸着式ヒートポンプのシステムの動作状態を示すサイクル図。

【図８】実施形態例３にかかる吸着式ヒートポンプと同一温度条件で運転した場合の従来技術にかかる吸着式ヒートポンプのサイクル図。

【図９】実施形態例４にかかる，吸着式ヒートポンプのシステムの動作状態を示すサイクル図。

【符号の説明】

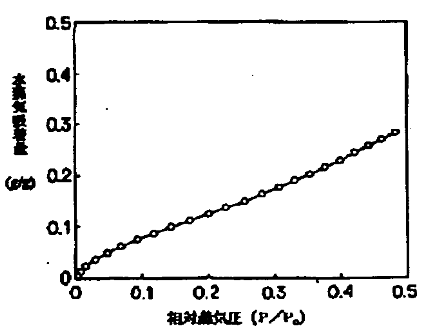
１，２．．．吸着式ヒートポンプ，

１１，１２．．．反応容器，

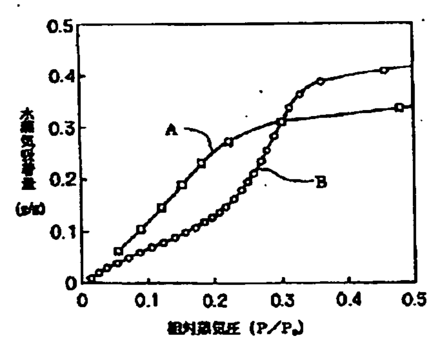
１３．．．蒸発器，

１４．．．凝縮器，

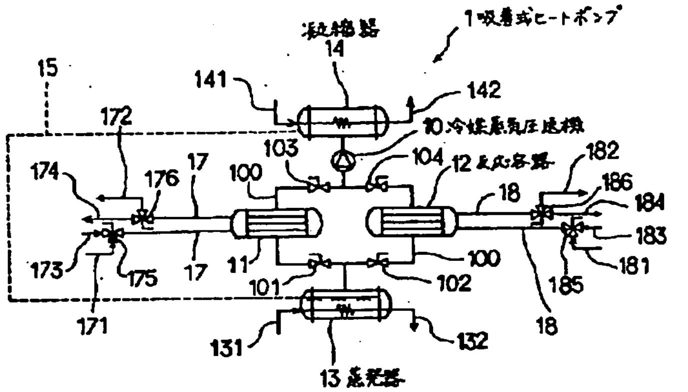
【図３】



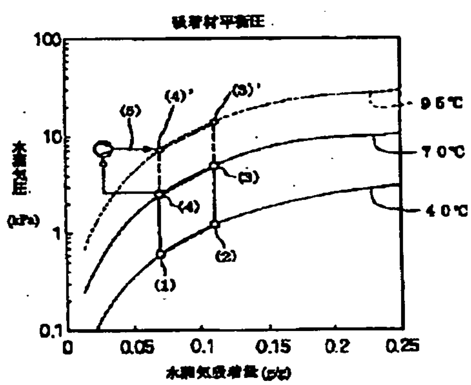

【図６】



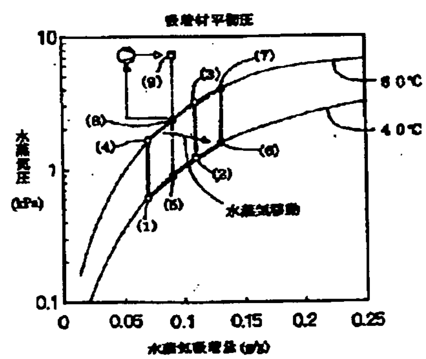
【図1】


1 吸着式ヒートポンプ
凝縮器
14
10 冷媒蒸気圧縮機
12 反応容器
13 蒸発器
15
141
142
172
174
176
17
100
103
104
182
186
18
184
183
181
185
173
175
11
101
102
171
131
132

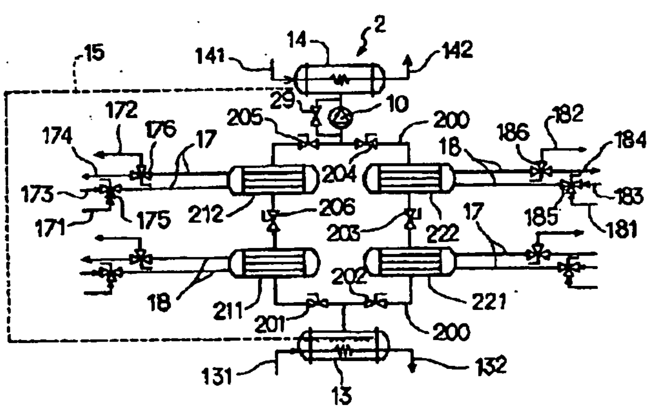
【図2】


吸着材平衡圧
水蒸気圧
(kPa)
水蒸気吸着量(g/g)
95℃
70℃
40℃
100
10
1
0.1
0
0.05
0.1
0.15
0.2
0.25

【図5】


吸着材平衡圧
水蒸気圧
(kPa)
水蒸気吸着量(g/g)
水蒸気移動
60℃
40℃
10
1
0.1
0
0.05
0.1
0.15
0.2
0.25

【図4】


2
14
141
142
15
29
10
205
200
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174
176
17
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182
184
18
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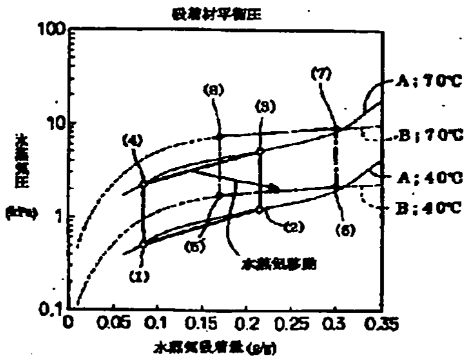
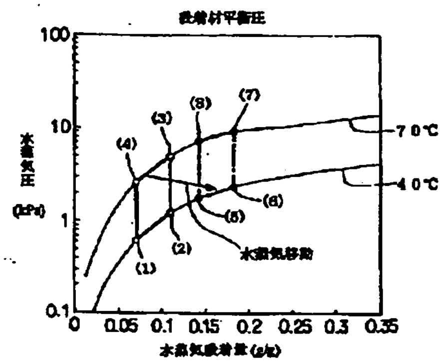
183
171
175
212
206
203
222
185
181
202
211
221
201
131
132
13

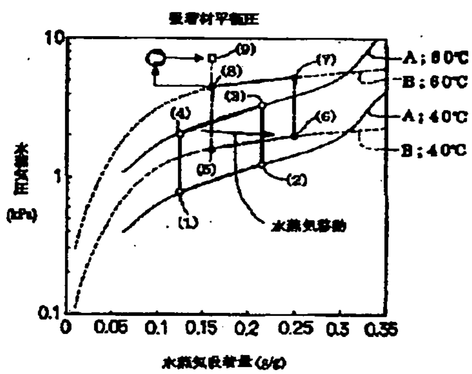
【図7】




【図8】




【図9】

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# PATENT ABSTRACTS OF JAPAN

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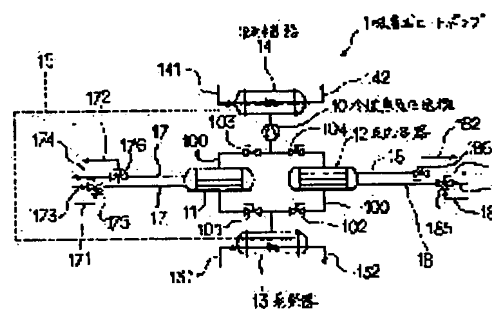
AOKI HIROSHI
YOKOI YUTAKA

## (54) ADSORPTION HEAT PUMP

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an adsorption heat pump whose structure can be easily made compact and which can be used, even when the temperatuere of a cooling source for cooling an adsorbent in an adsorption stroke is higher and the temperature of a heat source for heating the adsorbent in a regeneration stroke is higher.
SOLUTION: An adsorption heat pump 1 comprises an adsorbent capable of adsorbing and desorbing refrigerant steam, reaction vessels 11 and 12 with which the adsorbent is filled and which transfer reaction heat due to the adsorption and desorption of the refrigerant steam to a heating medium, an evaporator 13 for taking out cold heat obtained from the evaporation of refrigerant liquid, a condenser 14 for radiating outside hot heat obtained from the condensation of the refrigerant steam, and a refrigerant steam pressure machine 10 for raising the pressure of the refrigerant steam and transporting it. The refrigerant steam pressure machine 10 is designed to reduce the pressure of the reaction vessels 11 and 12 in their regeneration stroke.



LEGAL STATUS
[Date of request for examination]
[Date of sending the examiner's decision of rejection]
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]
[Date of final disposal for application]
[Patent number]
[Date of registration]
[Number of appeal against examiner's decision of rejection]
[Date of requesting appeal against examiner's decision of rejection]
[Date of extinction of right]

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CLAIMS

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[Claim(s)]
[Claim 1] The reaction container which the adsorption material in which adsorption and desorption are possible, and adsorption material are filled up with a refrigerant steam, and transmits the heat of reaction by the adsorption and desorption of a refrigerant steam to a heat carrier, The evaporator which takes out to the exterior the cold energy obtained by evaporation of refrigerant liquid, and the condenser which radiates heat to the exterior in the warm temperature obtained by condensation of a refrigerant steam, It is the adsorption equation heat pump which consists of a refrigerant steamy gas compressor which performs pressure-up transportation of a refrigerant steam, and is characterized by constituting this refrigerant steamy gas compressor so that the above-mentioned reaction container in a playback process may be decompressed.
[Claim 2] Two or more kinds of adsorption material from which adsorption and desorption are possible, and an adsorption property differs a refrigerant steam, respectively, The reaction container which adsorption material with low adsorption equilibrium pressure and adsorption material with high adsorption equilibrium pressure are filled up with the same temperature conditions, respectively, and transmits the heat of reaction by the adsorption and desorption of a refrigerant steam to a heat carrier, By the evaporator which takes out to the exterior the cold energy obtained by evaporation of refrigerant liquid, and condensation of a refrigerant steam Adsorption equation heat pump characterized by consisting of reaction containers with which it consisted of a condenser which radiates heat to the exterior in the obtained warm temperature, and filled up with adsorption material with low adsorption equilibrium pressure so that a refrigerant steam may be transported to the reaction container with which it filled up with adsorption material with high adsorption equilibrium pressure.

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[Translation done.]

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to adsorption equation heat pump available to a refrigerator, a refrigerator, an air conditioner, etc.
[0002]
[Description of the Prior Art] The adsorption material in which adsorption and desorption are possible, and adsorption material are filled up with a refrigerant steam, and the adsorption-equation heat pump which is used for various kinds of refrigerators, a refrigerator, an air conditioner, etc. has the structure where of the reaction container with which the adsorption and desorption of a refrigerant steam are performed, the evaporator which takes out to the exterior the cold energy obtained by evaporation of refrigerant liquid, and the condenser which emits the warm temperature obtained by condensation of a refrigerant steam to the exterior were mutually connected by piping, the bulb etc., respectively
[0003] the above-mentioned adsorption equation heat pump — setting — a refrigerant steam — the reaction container from an evaporator — moreover, while circulating from a reaction container to a condenser, a reaction container is heated or cooled by turns by the source of heating, and the source of cooling — having — this heating or cooling — responding — the adsorption material in a reaction container — a refrigerant steam — adsorption — or desorption is carried out. This serves as adsorption or a playback process.
[0004] By adsorption equation heat pump, adsorption-and-desorption difference-of-quantity deltaX (=Xa-Xd) which is generally the difference of the refrigerant steamy amount of adsorption Xa in an adsorption stroke and the refrigerant steamy amount of adsorption Xd in a playback process serves as a source of a thermal output. The refrigerant steamy amount of adsorption is determined by relative vapor pressure P/Po which is the ratio of the saturation pressure Po of the refrigerant steam corresponding to the temperature of adsorption material, and the pressure P of the refrigerant steam in a system (for example, evaporator).
[0005] so that whenever [ adsorption material temperature / which increases, so that whenever / adsorption material temperature / which Xa has in an adsorption stroke / is low in adsorption equation heat pump (P/Po is size), and Xd has in a playback process ] is high — decreasing (P/Po being smallness) — if it is not Xa>Xd, adsorption equation heat pump will not function. That is, since it is heated or cooled by the source of heating, and the source of cooling, adsorption material needs for the temperature gradient of the source of heating and the source of cooling to be large to some extent for actuation of adsorption equation heat pump.
[0006] He was trying for temperature required for a playback process not to become not much high by the conventional adsorption equation heat pump by lowering the temperature of an adsorption stroke, using low-temperature cooling water (30 degrees C or less) as a source of cooling. Thereby, low-temperature waste heat etc. can be used now as a source of heating of a playback process. Or the cooling water which is an elevated temperature beyond the temperature (about 30 degrees C) acquired in a cooling tower can be used now by raising the temperature of a playback process, using an elevated-temperature heat source (80 degrees C or more) as a source of heating.
[0007]
[Problem(s) to be Solved] However, there are the following troubles in the conventional adsorption equation heat pump. In adsorption equation heat pump, when the about 30-degree C cooling water obtained by the cooling tower etc. is used as a source of cooling, in order to obtain 10-degree C cold energy, the source of heating 70 degrees C or more is needed.
[0008] It was very difficult for using a cooling tower to secure 30-degree C low-temperature cooling water by air-conditioners for mount, such as difficult home use and an automobile, at summer (environmental condition from which an OAT becomes about 35 degrees C). Furthermore, when the temperature of cooling water becomes about 40 degrees C, the hot source of heating 95 degrees C or more is needed. Such a source of heating had the problem that it was unrealizable unless it uses heating means, such as a boiler. For this reason, it was difficult to be easy to enlarge equipment and to use as an air conditioner for home use and mount.
[0009] By the way, the method of realizing the playback process of adsorption equation heat pump using the low-temperature source of heating more is indicated by JP,5-248727,A. Here, the adsorption equation heat pump which connected and constituted two steps of adsorption towers (reaction container) in the serial between the evaporator and the condenser is indicated. This heat pump is characterized by conveying the refrigerant steam to which it stuck in the 1st step of adsorption tower (reaction container) using the difference of the 1st step of desorption equilibrium pressure, and adsorption [ the 2nd step of ] equilibrium pressure to the 2nd step of adsorption tower (reaction container) which the playback process ended.
[0010] The above-mentioned adsorption equation heat pump can obtain 10-degree C cold energy by using the about 50-degree C source of heating, when about 30-degree C cooling water is used as a source of cooling. Moreover, in the above-mentioned conventional technique, the 30-degree C source of cooling in summer uses a cooling tower (cooling tower), and the 50-degree C source of heating supposes that exhaust heat of works, a thermal power station, etc. can be used.
[0011] However, as adsorption equation heat pump with which the application of the air-conditioner for mount etc. is still provided from a cooling tower etc. being required also in the above-mentioned conventional technique, it is inadequate. Furthermore, in the above-mentioned conventional technique, since adsorption equation heat pump is

operated in the field where change of the equilibrium pressure to the refrigerant steamy amount of adsorption is large when the circulating water temperature used as the source of cooling is high, in order to secure enough the adsorption-and-desorption difference of quantity of a refrigerant steam, temperature of the source of heating needed to be made high. For this reason, although the source of heating could be made into 50 degrees C under the condition from which the source of cooling becomes 30 degrees C, for example, when the source of cooling is made into 40 degrees C, in order to secure identity ability, the source of heating needed to be made into 80 degrees C or more.
[0012] The source of heating of this invention which heats adsorption material at a playback process when the source of cooling which cools adsorption material in an adsorption stroke in view of this trouble is higher temperature is usable at lower temperature, and the miniaturization of the equipment physique tends to offer easy adsorption equation heat pump.
[0013]
[Means for Solving the Problem] The reaction container which the adsorption material in which adsorption and desorption are possible, and adsorption material are filled up with a refrigerant steam to invention of claim 1, and transmits the heat of reaction by the adsorption and desorption of a refrigerant steam to a heat carrier, The evaporator which takes out to the exterior the cold energy obtained by evaporation of refrigerant liquid, and the condenser which radiates heat to the exterior in the warm temperature obtained by condensation of a refrigerant steam, It consists of a refrigerant steamy gas compressor which performs pressure-up transportation of a refrigerant steam, and this refrigerant steamy gas compressor is in the adsorption equation heat pump characterized by being constituted so that the above-mentioned reaction container in a playback process may be decompressed.
[0014] It explains below about an operation of this invention. In this invention, it is constituted so that the reaction container which has a refrigerant steamy gas compressor in a playback process may be decompressed. Therefore, it becomes movable [ the refrigerant steam from a reaction container ], and the playback process of a reaction container can be promoted more.
[0015] For this reason, the low-temperature source of heating and the hotter source of cooling are used more, and even if it is a case so that both temperature gradient may not function as adsorption equation heat pump by the former small, the adsorption equation heat pump concerning this invention can function. Moreover, since the low-temperature source of heating and the hotter source of cooling can be used more, a facility of a cooling tower, a boiler, etc. becomes unnecessary and the miniaturization of the equipment physique can be attained. Furthermore, since the cooling tower, the boiler, etc. are unnecessary, it becomes possible to use as home use and an air-conditioner for mount.
[0016] As mentioned above, according to this invention, at temperature with the higher source of cooling which cools adsorption material in an adsorption stroke, when the source of heating which heats adsorption material at a playback process is lower temperature, it is usable, and the miniaturization of the equipment physique can offer easy adsorption equation heat pump.
[0017] Next, it is desirable to arrange the reaction container filled up with adsorption material two or more vessels to between an evaporator and refrigerant steamy gas compressors (example of operation gestalt 2 reference). Thereby, a refrigerant steam is movable between reaction containers using the equilibrium-vapor-pressure difference of adsorption material. Thereby, desorption temperature can be made still lower. Moreover, the above-mentioned refrigerant steamy gas compressor can also be arranged between the reaction containers of two vessels.
[0018] Next, two or more kinds of adsorption material from which adsorption and desorption are possible for invention of claim 2 in a refrigerant steam, and an adsorption property differs, respectively, The reaction container which adsorption material with low adsorption equilibrium pressure and adsorption material with high adsorption equilibrium pressure are filled up with the same temperature conditions, respectively, and transmits the heat of reaction by the adsorption and desorption of a refrigerant steam to a heat carrier, By the evaporator which takes out to the exterior the cold energy obtained by evaporation of refrigerant liquid, and condensation of a refrigerant steam It consists of a condenser which radiates heat to the exterior in the obtained warm temperature, and is in the adsorption equation heat pump characterized by consisting of reaction containers with which it filled up with adsorption material with low adsorption equilibrium pressure so that a refrigerant steam may be transported to the reaction container with which it filled up with adsorption material with high adsorption equilibrium pressure (example of operation gestalt 3 reference).
[0019] It explains below about an operation of invention concerning this claim. The adsorption equation heat pump of this invention has the reaction container filled up with adsorption material with low adsorption equilibrium pressure, and the reaction container filled up with adsorption material with high adsorption equilibrium pressure, and it is constituted so that a refrigerant steam may be transported to the latter reaction container from the former reaction container. Therefore, while the adsorption in an elevated temperature becomes easy by the low adsorption material of adsorption equilibrium pressure and playback at low temperature becomes easy by the high adsorption material of adsorption equilibrium pressure, the playback process of low voltage adsorption material and the adsorption process of high-pressure adsorption material can be promoted more.
[0020] For this reason, the low-temperature source of heating and the hotter source of cooling are used more, and even if it is a case so that both temperature gradient may not function as adsorption equation heat pump by the former small, the adsorption equation heat pump concerning this invention can function. Moreover, since the low-temperature source of heating and the hotter source of cooling can be used more, a facility of a cooling tower, a boiler, etc. becomes unnecessary and the miniaturization of the equipment physique can be attained. Furthermore, since the cooling tower, the boiler, etc. are unnecessary, it becomes possible to use as home use and an air-conditioner for mount. An available reaction field (adsorption-and-desorption difference of quantity of a refrigerant steam) is sharply expandable by using two more or more kinds of adsorption material.
[0021] As mentioned above, according to this invention, at temperature with the higher source of cooling which cools adsorption material in an adsorption stroke, when the source of heating which heats adsorption material at a playback process is lower temperature, it is usable, and the miniaturization of the equipment physique can offer easy adsorption equation heat pump.
[0022] Next, the reaction container which adsorption and desorption are possible, and adsorption material with low adsorption equilibrium pressure and adsorption material with high adsorption equilibrium pressure are filled up with the same temperature conditions in a refrigerant steam, respectively, and transmits the heat of reaction by the adsorption and desorption of a refrigerant steam to a heat carrier, When heat is radiated to the exterior, the evaporator which takes out to the exterior the cold energy obtained by evaporation of refrigerant liquid, and the warm temperature

obtained by condensation of a refrigerant steam A condenser, It is desirable to consist of reaction containers with which it consisted of a refrigerant steamy gas compressor which performs pressure-up transportation of a refrigerant steam, and filled up with adsorption material with low adsorption equilibrium pressure so that a refrigerant steam may be transported to the reaction container with which it filled up with adsorption material with high adsorption equilibrium pressure (example of operation gestalt 4 reference).

[0023] In this case, since it is constituted so that the reaction container which has a refrigerant steamy gas compressor in a playback process may be decompressed, it becomes movable [ the refrigerant steam from a reaction container ], and the playback process of a reaction container can be promoted more. Moreover, by combining the low adsorption material of adsorption equilibrium pressure, and the high adsorption material of adsorption equilibrium pressure on the same temperature conditions, even when whenever [ in an adsorption stroke / adsorption material temperature ] is high, a refrigerant steam can be adsorbed easily, and an elevated-temperature heat source is not needed in a playback process, but an available reaction field (adsorption-and-desorption difference of quantity of a refrigerant steam) can be sharply expanded by using two more or more kinds of adsorption material.

[0024]

[Embodiment of the Invention] It explains using drawing 1 - drawing 3 about the adsorption equation heat pump concerning the example of an operation gestalt of example of operation gestalt 1 this invention. As shown in drawing 1 , the adsorption equation heat pump 1 of this example The reaction containers 11 and 12 which the adsorption material in which adsorption and desorption are possible, and adsorption material are filled up with a refrigerant steam, and transmit the heat of reaction by the adsorption and desorption of a refrigerant steam to a heat carrier, The evaporator 13 which takes out to the exterior the cold energy obtained by evaporation of refrigerant liquid, and the condenser 14 which radiates heat to the exterior in the warm temperature obtained by condensation of a refrigerant steam, It consists of a refrigerant steamy gas compressor 10 which performs pressure-up transportation of a refrigerant steam, and this refrigerant steamy gas compressor 10 is constituted so that the above-mentioned reaction containers 11 and 12 in a playback process may be decompressed.

[0025] Next, the adsorption equation heat pump 1 concerning this example is explained to a detail. As shown in drawing 1 , the reaction containers 11 and 12 with which it filled up with adsorption material are mutually connected by the refrigerant steam line 100, and the control bulbs 101-104 are formed in this refrigerant steam line 100.

[0026] Moreover, the evaporator 13 is connected to the refrigerant steam line 100. Moreover, the condenser 14 is connected to the refrigerant steam line 100 through the refrigerant steamy gas compressor 10. Moreover, the reaction containers 11 and 12 are connected to juxtaposition between the evaporator 13 and the condenser 14. Moreover, between the condenser 14 and the evaporator 13, the return piping 15 for returning the refrigerant liquid condensed with the condenser to an evaporator 13 is formed. In addition, the inlet port of the cold water with which a sign 131 serves as an air conditioning output from an evaporator 13, and a sign 141 are the inlet ports of the cooling water to a condenser 14. A sign 132,142 is the outlet of cold water and each cooling water. Moreover, the indoor space (air-conditioning space) which is not illustrated, the interior unit arranged possible [ heat exchange ], and the pump which circulates through cold water are connected to the cold-water piping 131,132.

[0027] Moreover, the thermal piping 17 is connected to the reaction container 11, the thermal piping 18 is connected to the reaction container 12, respectively, it changes to these thermal piping 17 and 18, and bulbs 175,176 and 185,186 are formed. Moreover, the heat carrier used as the source of heating for the thermal piping 17 and 18 to heat or cool the reaction container 11 and the adsorption material in 12 or the source of cooling is circulating. The heat carriers of this example are warm water (70 degrees C) and cooling water (40 degrees C).

[0028] Warm water is introduced from an inlet port 173,183 by closing motion of the change bulb 175,176,185,186, passes each reaction containers 11 and 12, and is drawn from an outlet 174,184. Cooling water is also introduced from an inlet port 171,181 by closing motion of the same change bulb 175,176,185,186, passes each reaction containers 11 and 12, and is drawn from an outlet 172,182. Moreover, the open air which is not illustrated, the exterior unit arranged possible [ heat exchange ], the calorifier which generates warm water, and the pump which circulates through a heat carrier are connected to the thermal piping 17 and 18.

[0029] The above-mentioned reaction containers 11 and 12 are filled up with the silica gel which is adsorption material. Moreover, pure water was used as the refrigerant liquid concerning this example, and a refrigerant steam. Moreover, as a heat carrier which acts as the source of heating to the reaction containers 11 and 12, and a source of cooling, the usual tap water (or brine [the antifreezing solution]) was used. In addition, the relation between relative vapor pressure P/Po which is the ratios of the saturation pressure Po of the steam corresponding to the steam amount of adsorption of the above-mentioned silica gel and the temperature of adsorption material and the pressure P of the steam in a reaction container was indicated to drawing 3 .

[0030] Actuation of the adsorption equation heat pump 1 concerning this example is explained. About by the 1st line, closing and the control bulb 102,103 were wide opened for the control bulb 101,104, and the adsorption stroke was performed for the playback process in the reaction container 12 in the reaction container 11. Moreover, the change bulb 175,176,185,186 is operated at this time, warm water was circulated to the thermal pipe 17, and cooling water was circulated to the thermal pipe 18.

[0031] The reaction container 12 is cooled by about 40 degrees C with the cooling water cooled by carrying out heat exchange to the open air. Moreover, the water in an evaporator 13 evaporates by open actuation of the control bulb 102, and it becomes a steam, and flows into the reaction container 12, and adsorption material is adsorbed. Steam migration is performed by the difference of the maximum vapor tension in evaporation temperature, and the adsorption equilibrium pressure corresponding to [ whenever / adsorption material temperature ] 40 degrees C, and the cold energy corresponding to evaporation temperature, i.e., an air conditioning output, is obtained in an evaporator 13. Since the cold water which flows an evaporator 13 serves as an air conditioning output, evaporation temperature lower than inlet-port cold-water temperature needs this cold water to be cooled. The temperature at this time is evaporation temperature, and operation was performed at the evaporation temperature of 10 degrees C in this example.

[0032] Although the reaction container 11 in a playback process is heated with 70-degree C warm water and it becomes the desorption equilibrium pressure corresponding to 70 degrees C, since maximum vapor tension with a condensation temperature [ of a condenser 14 ] of 40 degrees C (this [ abbreviation's ] being in the temperature of the cooling water which has cooled the condenser by carrying out) is higher than the desorption equilibrium pressure in 70 degrees C, the way things stand, migration of a steam is not performed.

[0033] Then, the refrigerant steamy gas compressor 10 is operated in parallel with open actuation of the

above-mentioned control bulb 104. The refrigerant steamy gas compressor 10 can carry out the pressure up of the steam inhaled from the reaction container 11, and can carry out it to more than maximum vapor tension with a condensation temperature of 40 degrees C. It becomes movable [ a steam ] from the reaction container 11 to a condenser 14, and the playback process of the reaction container 11 is performed. A steam is condensed with a condenser 14 and it becomes water. Water is returned to an evaporator 13 with the return tubing 15. The above is about the 1st line.
[0034] About in the following line [ 2nd ], the reaction container 11 can obtain cold energy, i.e., an air conditioning output, from an evaporator 13 similarly by changing the control bulbs 101-104 and the change bulb 175,185,176,186 so that an adsorption stroke and the reaction container 12 may serve as a playback process. Continuous running of the adsorption equation heat pump 1 was performed by changing the 1st of a more than, and about the 2nd line one by one.

[0035] Next, an operating state is explained with the cycle Fig. of the adsorption equation heat pump 1. The line of the adsorption material equilibrium pressure which showed the relation of the water vapor pressure and the steam amount of adsorption in the temperature of 40 degrees C, 70 degrees C, and 95 degrees C is indicated by drawing 2 . Moreover, the pressure of (4)' in this drawing is equal to the maximum vapor tension of the water in the temperature of 40 degrees C. The cycle concerning (1) ->(2) ->(3) -> (4) indicated as the continuous line in this drawing is the adsorption equation heat pump concerning this example.
[0036] The reaction container 12 which desorption finished with the last process is in the condition of (4), and is cooled to the condition of (1) with cooling water in advance of a change in an adsorption stroke. Steam adsorption is started from an evaporator 13 by open actuation of the control bulb 102, and (2) HE amount of adsorption increases. The reaction container 11 which adsorption completed at the last process is in the condition of (2), and a temperature up is carried out to the condition of (3) with warm water in advance of a change at a playback process. By open actuation of the control bulb 103 and operation of the refrigerant steamy gas compressor 10, adsorption material equilibrium pressure extent obtained by (4) decompresses, the amount of adsorption decreases to the condition of (4), and desorption completes the reaction container 11. The pressure up of the steam is carried out from (4) to (5) by the refrigerant steamy gas compressor, and it is sent to a condenser 14. It condenses here and becomes water. This water is returned to an evaporator 13 with the return tubing 15.
[0037] Moreover, although it was the completely same structure as the adsorption equation heat pump applied to this example at drawing 2 , the broken line indicated the cycle of the thing of structure conventionally without a refrigerant steamy gas compressor. this cycle — (1) ->(2) -> (3) — it is '-> (4)'. As found in this drawing, in order to obtain conventionally the same engine performance (steam adsorption-and-desorption difference of quantity) as what performs operation at 40 degrees C and the evaporation temperature of 10 degrees C, and starts this example further in the adsorption material in an adsorption stroke from the heat pump of structure like the adsorption equation heat pump 1 concerning this example, it turned out that the adsorption material in a playback process must be held at 95 degrees C or more.
[0038] The warm water used as the source of heating for holding adsorption material at 95 degrees C or more is not obtained easily practically, and needs a facility of a boiler etc. Therefore, under the conditions from which low-temperature cooling water is not obtained, the operation itself was conventionally difficult for the adsorption equation heat pump of structure.
[0039] Next, it explains per [ in this example ] operation effectiveness. The adsorption equation heat pump concerning this example has the refrigerant steamy gas compressor 10, and this refrigerant steamy gas compressor 10 can carry out the pressure up of the steam inhaled from the reaction containers 11 and 12, and can carry out it to more than maximum vapor tension with a condensation temperature of 40 degrees C. It becomes movable [ a steam ] from the reaction containers 11 and 12 to a condenser 14, and the playback process of the reaction containers 11 and 12 is performed. When the adsorption material in an adsorption stroke is cooled at 40 degrees C and operation is performed at the evaporation temperature of 10 degrees C by this, even if the adsorption material in a playback process is about 70 degrees C, adsorption equation heat pump can be operated.
[0040] For this reason, installation of the cooling tower for obtaining low-temperature cooling water or hot warm water or a boiler becomes unnecessary, and an installation cost and a running cost can be reduced greatly. Moreover, it can consider as small and compact equipment from installation of a cooling tower, a boiler, etc. being unnecessary, and can consider as the equipment which can be installed in the narrow tooth space to which home use, the object for mount, etc. were restricted.
[0041] Therefore, according to this example, at temperature with the higher source of cooling which cools adsorption material in an adsorption stroke, when the source of heating which heats adsorption material at a playback process is lower temperature, it is usable, and the miniaturization of the equipment physique can offer easy adsorption equation heat pump.
[0042] In addition, by this example, although reduced pressure actuation of the reaction containers 11 and 12 was made to become 3 or less times with the compression ratio (a discharge pressure/suction pressure) of the refrigerant steamy gas compressor 10, under the service condition which does not pose a problem, the playback of enlargement of the refrigerant steamy gas compressor 10 or increase of consumption power at low temperature is still also attained by lowering suction pressure.
[0043] It explains using drawing 4 and drawing 5 per adsorption equation heat pump of the example of two examples of an operation gestalt. As shown in drawing 4 , the adsorption equation heat pump 2 concerning this example has the same configuration as the thing concerning drawing 1 of the example 1 of an operation gestalt. However, between the refrigerant steamy gas compressor 10 and the evaporator 13, the reaction container 211,212,221,222 which it has arranged at a time to the serial two vessels is formed.
[0044] Actuation of the adsorption equation heat pump 2 concerning this example is explained. About by the 1st line, closing and the control bulb 201,203,205 were wide opened for the control bulb 202,204,206, and the adsorption stroke was performed for the playback process in the reaction container 211,222 in the reaction container 212,221. Moreover, the change bulb 175,176,185,186 is operated at this time, 60-degree C warm water was circulated to the thermal pipe 17, and 40-degree C cooling water was circulated to the thermal pipe 18.
[0045] The reaction container 211 is cooled by about 40 degrees C with the cooling water cooled by carrying out heat exchange to the open air. Moreover, the water in an evaporator 13 evaporates by open actuation of the control bulb 201, and it becomes a steam, and flows into the reaction container 211, and adsorption material is adsorbed. Steam

migration is performed by the difference of the maximum vapor tension in evaporation temperature, and the adsorption equilibrium pressure corresponding to [ whenever / adsorption material temperature ] 40 degrees C, and the cold energy corresponding to evaporation temperature, i.e., an air conditioning output, is obtained in an evaporator 13. Since the cold water which flows an evaporator 13 serves as an air conditioning output, evaporation temperature lower than inlet-port cold-water temperature needs this cold water to be cooled. In this example, operation was performed at the evaporation temperature of 10 degrees C.

[0046] Moreover, the reaction container 212,221 is heated with the 60-degree C warm water introduced into the thermal pipe 17, and a steam is desorbed from the adsorption material in a reaction container. The steam from the reaction container 221 flows into the reaction container 222 via the control bulb 203 opened wide, and this reaction container 222 is held at 40 degrees C in the 40-degree C heat carrier introduced into the thermal pipe 18. For this reason, adsorption of a steam is performed. And the steam desorbed from the reaction container 212 flows into a condenser 14 through the control bulb 205 opened wide. Although it is cooled and a steam serves as water here, this water is returned to an evaporator 13 with the return tubing 15.

[0047] Steam migration between the reaction containers 221,222 mentioned above is performed by differential pressure with a desorption equilibrium pressure [ of 60 degrees C ], and an adsorption equilibrium pressure of 40 degrees C. Moreover, steam migration to a condenser 14 from the reaction container 212 is performed by operating the refrigerant steamy gas compressor 10 in parallel with open actuation of the control bulb 205 like the example 1 of an operation gestalt.

[0048] About in the following line [ 2nd ], the reaction container 212,221 changes the control bulbs 201-206 and the change bulb 175,185,176,186 so that an adsorption stroke and the reaction container 211,222 may serve as a playback process. Thereby, cold energy can be similarly obtained from an evaporator 13. Continuous running of the adsorption equation heat pump 2 was performed by changing the 1st of a more than, and about the 2nd line one by one. Others are the same as that of the example 1 of an operation gestalt.

[0049] In addition, in this example, in the service condition from which hot warm water 70 degrees C or more is obtained, a bypass valve 29 is opened and operation of the refrigerant steamy gas compressor 10 is suspended, and it is constituted so that steam migration to the direct condenser 14 from the reaction container 222 can also be performed. In this case, the power consumption of the refrigerant steamy gas compressor 10 can be reduced.

[0050] Next, an operating state is explained with the cycle Fig. of the adsorption equation heat pump 2. The line of the adsorption material equilibrium pressure which showed the relation between the temperature of 40 degrees C, and the water vapor pressure and the steam amount of adsorption in 60 degrees C is indicated by drawing 5 . Moreover, the pressure of (9) in this drawing is equal to the maximum vapor tension of the water in the temperature of 40 degrees C. A white round head shows the cycle of the reaction container 211,221 by the side of an evaporator 13 among two cycles shown in this drawing, and the black dot shows the cycle of the reaction container 212,222. Moreover, adsorption stroke (4) ->(1) -> (2) of the reaction container 221 is the same as that of the example 1 of an operation gestalt.

[0051] The reaction container 211 which adsorption completed like the previous line is in the condition of (2), and a temperature up is carried out to (3) with warm water in advance of a change at a playback process. On the other hand, the reaction container 212 which desorption completed like the previous line is in the condition of (8), and is cooled to (5) with cooling water in advance of a change in an adsorption stroke.

[0052] Steam migration (arrow in drawing 5 ) by the differential pressure of (3) and (5) is performed by performing open actuation of the control bulb 206, as for the adsorption material of the reaction container 211, the amount of adsorption decreases from (3) to (4) (desorption carried out), the amount of adsorption increases to (6) from (5), and the adsorption material of the reaction container 212 serves as the completion of adsorption.

[0053] The reaction container 222 which adsorption completed like the previous line is reproduced with (6) ->(7) -> (8) by the same actuation as the example 1 of an operation gestalt, the pressure up of the steam is carried out to (9) from (8), and it is sent to a condenser 14. Others are the same as that of the example 1 of an operation gestalt.

[0054] The adsorption equation heat pump 2 of this example can offer the system with very high practical use value by which cooling water becomes available also under the environment which does not use a cooling tower like an air-conditioner for home use or the air-conditioner for automobiles from the ability to operate at the high temperature of 40 degrees C, for example. Furthermore, 60-degree C warm water can divert an engine cooling water in an automobile, and can divert it from these equipments at the home equipped with hot-water heating or warm water floor heating.

[0055] As shown in drawing 6 and drawing 7 , the example of three examples of an operation gestalt is the adsorption equation heat pump of the structure concerning drawing 4 of the example 2 of an operation gestalt, and is considered as the configuration which does not use a refrigerant steamy gas compressor. However, each of two reaction containers was filled up with the adsorption material from which a property differs as shown in drawing 6 . That is, one side (reaction container concerning the sign 211,221 concerning drawing 4 ) of the above-mentioned reaction container is filled up with the low adsorption material A of adsorption equilibrium pressure as shown in the continuous line A of drawing 6 . Another side (reaction container concerning the sign 212,222 concerning drawing 4 ) is filled up with the high adsorption material B of adsorption equilibrium pressure as shown in the continuous line B of drawing 6 .

[0056] As adsorption material of this example, the meso porous molecular sieve (FSM) currently indicated by JP,9-178292,A was suitable. Above FSM was doubled with the service temperature region, and it used it for this example, having improved in part.

[0057] Operation of the adsorption equation heat pump of this example can be performed like the example 2 of an operation gestalt. Although that detail is explained below, the sign concerning this explanation applies to drawing 4 correspondingly. That is, about by the 1st line, closing and the control bulb 201,203,205 were wide opened for the control bulb 202,204,206, and the adsorption stroke was performed for the playback process in the reaction container 211,222 in the reaction container 212,221. Moreover, it changes at this time and a bulb 175,176,185,186 is operated, 70-degree C warm water was circulated to the thermal pipe 17, and 40-degree C cooling water was circulated to the thermal pipe 18.

[0058] The reaction container 211 is cooled by about 40 degrees C with the cooling water cooled by carrying out heat exchange to the open air. Moreover, the water in an evaporator 13 evaporates by open actuation of the control bulb 201, and it becomes a steam, and flows into the reaction container 211, and adsorption material is adsorbed. Steam migration is performed by the difference of the maximum vapor tension in evaporation temperature, and the adsorption

equilibrium pressure corresponding to [ whenever / adsorption material temperature ] 40 degrees C, and the cold energy corresponding to evaporation temperature, i.e., an air conditioning output, is obtained in an evaporator 13. Since the cold water which flows an evaporator 13 serves as an air conditioning output, evaporation temperature lower than inlet-port cold-water temperature needs this cold water to be cooled. In this example, operation was performed at the evaporation temperature of 10 degrees C.

[0059] Moreover, the reaction container 212,221 is heated with the 70-degree C warm water introduced into the thermal pipe 17, and a steam is desorbed from the adsorption material in the reaction container 212,221. The steam from the reaction container 221 flows into the reaction container 222 via the control bulb 203 opened wide. The reaction container 222 is held in the heat carrier introduced into the thermal pipe 18 at 40 degrees C. For this reason, adsorption of a steam is performed. The steam desorbed from the reaction container 212 flows into a condenser 14 through the control bulb 205 opened wide. Although it is cooled and a steam serves as water here, this water is returned to an evaporator 13 with the return tubing 15.

[0060] Moreover, steam migration between the reaction containers 221,222 mentioned above is performed by differential pressure with a desorption equilibrium pressure [ of 70 degrees C ] (reaction container 221), and an adsorption equilibrium pressure (reaction container 222) of 40 degrees C. Moreover, since the desorption equilibrium pressure (reaction container 212) of 70 degrees C is more than the maximum vapor tension corresponding to the condensation temperature of 40 degrees C of a steam, the steam migration to a condenser 14 from the reaction container 212 is performing steam migration to the direct condenser 14.

[0061] About in the following line [ 2nd ], the reaction container 212,221 changes the control bulbs 201-206 and the change bulb 175,185,176,186 so that an adsorption stroke and the reaction container 211,222 may serve as a playback process. Thereby, cold energy can be similarly obtained from an evaporator 13. Continuous running of the adsorption equation heat pump 2 was performed by changing the 1st of a more than, and about the 2nd line one by one. Others are the same as that of the example 1 of an operation gestalt.

[0062] By the adsorption equation heat pump concerning this example, comparatively many steams can be adsorbed also under the conditions that a circulating water temperature is high, by using the low adsorption material A of adsorption equilibrium pressure for one side of a reaction container. Moreover, desorption of the steam can be carried out at comparatively low temperature by using the high adsorption material B of adsorption equilibrium pressure for the reaction container of another side. moreover, the conventional technique using the same adsorption material although the adsorption material A and the adsorption material B also need to take into consideration and select the steam migration between reaction containers — a ratio — BE — **** — since it is used combining the adsorption material of adsorption equilibrium pressure, steam migration between reaction containers can also be performed easily.

[0063] Drawing 7 is the cycle Fig. of the adsorption equation heat pump concerning this example. In addition, the line of the adsorption material equilibrium pressure which showed the temperature of 40 degrees C of each adsorption material A and B and the relation of the water vapor pressure and the steam amount of adsorption in 70 degrees C is indicated by drawing 7 . This was compared with the cycle Fig. by the conventional technique of drawing 8 .

[0064] The structure of the adsorption equation heat pump concerning drawing 8 is completely the same as the adsorption equation heat pump concerning this example. However, the reaction container is filled up with the same adsorption material. For this reason, when [ which was high ] the temperature of cooling water called it 40 degrees C, unless it used warm water 70 degrees C or more, steam adsorption-and-desorption difference of quantity could not be secured, but ** and regenerating temperature of 70 degrees C in which a system was not materialized compared.

[0065] Consequently, with the conventional technique, since the same adsorption material was used, only 0.04 g/g was able to secure steam adsorption-and-desorption difference of quantity. in addition — a steam — adsorption and desorption — difference of quantity — said — drawing — it can set — (— one —) - (— two —) — between — or — (— five —) - (— six —) — a difference — [— an axis of abscissa — a direction —] — from — it can read .

[0066] However, in the same evaluation conditions, about 0.13 g/g was [ steam adsorption-and-desorption difference of quantity ] securable by using different adsorption material like this example. That is, the very big value of 3 or so times of the conventional technique was able to be acquired. Therefore, it turned out that the same engine performance can be secured by the adsorption material of one third of amounts as compared with the adsorption equation heat pump concerning the conventional technique of drawing 8 , and the miniaturization of all equipment ** can be enabled.

[0067] By the above, since small and highly efficient adsorption equation heat pump is realizable according to this example, the application as the air-conditioner and the air-conditioner for automobiles for home use which have constraint in an installation etc. can offer very easy adsorption equation heat pump.

[0068] The example of four examples of an operation gestalt is the adsorption equation heat pump which filled up the example 3 of an operation gestalt with the low adsorption material A of the adsorption equilibrium pressure of a publication, and the high adsorption material B of adsorption equilibrium pressure to the adsorption equation heat pump applied to the example 2 of an operation gestalt as shown in drawing 9 . And the reaction container 211,221 concerning above-mentioned drawing 4 is filled up with the adsorption material A, and the reaction container 212,222 is filled up with the adsorption material B. Others are the same as that of the example 2 of an operation gestalt.

[0069] Moreover, although operation etc. is the same as that of the example 2 of an operation gestalt, a detail is explained below. In addition, in the following explanation, a sign applies to drawing 4 of the example 2 of an operation gestalt correspondingly. About by the 1st line, closing and the control bulb 201,203,205 were wide opened for the control bulb 202,204,206, and the adsorption stroke was performed for the playback process in the reaction container 211,222 in the reaction container 212,221. Moreover, the change bulb 175,176,185,186 is operated at this time, 60-degree C warm water was circulated to the thermal pipe 17, and 40-degree C cooling water was circulated to the thermal pipe 18.

[0070] The reaction container 211 is cooled by about 40 degrees C with the cooling water cooled by carrying out heat exchange to the open air. Moreover, the water in an evaporator 13 evaporates by open actuation of the control bulb 201, and it becomes a steam, and flows into the reaction container 211, and adsorption material is adsorbed. Steam migration is performed by the difference of the maximum vapor tension in evaporation temperature, and the adsorption equilibrium pressure corresponding to [ whenever / adsorption material temperature ] 40 degrees C, and the cold energy corresponding to evaporation temperature, i.e., an air conditioning output, is obtained in an evaporator 13. Since the cold water which flows an evaporator 13 serves as an air conditioning output, evaporation temperature lower than inlet-port cold-water temperature needs this cold water to be cooled. In this example, operation was performed at the

evaporation temperature of 10 degrees C.
[0071] Moreover, the reaction container 212,221 is heated with the 60-degree C warm water introduced into the thermal pipe 17, and a steam is desorbed from the adsorption material in a container. The steam from the reaction container 221 flows into the reaction container 222 via the control bulb 203 opened wide, and this reaction container 222 is held at 40 degrees C in the 40-degree C heat carrier introduced into the thermal pipe 18. Adsorption of a steam is performed with this reaction container 222. The steam desorbed from the reaction container 212 flows into a condenser 14 through the control bulb 205 opened wide. Although it is cooled and a steam serves as water here, this water is returned to an evaporator 13 with the return tubing 15.
[0072] Moreover, steam migration between the reaction containers 221,222 mentioned above is performed by differential pressure with a desorption equilibrium pressure [ of 60 degrees C ] (reaction container 221), and an adsorption equilibrium pressure (reaction container 222) of 40 degrees C. Moreover, steam migration to a condenser 14 from the reaction container 212 is performed by operating the refrigerant steamy gas compressor 10 in parallel with open actuation of the control bulb 205 like the example 1 of an operation gestalt.
[0073] About in the following line [ 2nd ], the reaction container 212,221 changes the control bulbs 201-206 and the change bulb 175,185,176,186 so that an adsorption stroke and the reaction container 211,222 may serve as a playback process. Thereby, cold energy can be similarly obtained from an evaporator 13. Continuous running of the adsorption equation heat pump 2 was performed by changing the 1st of a more than, and about the 2nd line one by one. Others are the same as that of the example 1 of an operation gestalt.
[0074] Drawing 9 is the cycle Fig. of the adsorption equation heat pump concerning this example. In addition, the line of the adsorption material equilibrium pressure which showed the temperature of 40 degrees C of each adsorption material A and B and the relation of the water vapor pressure and the steam amount of adsorption in 60 degrees C is indicated by drawing 9 . In addition, the detail of a cycle is the same as that of the example 2 of an operation gestalt. According to this drawing, the warm water of lower temperature can be used, securing sufficient quantity of a steam adsorption-and-desorption difference like the example 3 of an operation gestalt. Therefore, according to this example, adsorption equation heat pump with high engine performance from which large adsorption-and-desorption difference of quantity is obtained with 60-degree C warm water can be obtained.
[0075] In addition, in this example, the compression ratio of a refrigerant steamy gas compressor is operated as a 2 double less or equal, and reduction of consumption power can be aimed at more. Moreover, when the compression ratio of a refrigerant steamy gas compressor is enlarged more and it operates, operation as adsorption equation heat pump can be enabled for the temperature of warm water to be still lower. As mentioned above, the adsorption equation heat pump of this example is applicable as air conditioners, such as ordinary homes. thus, according to this example, the application place of adsorption equation heat pump can be boiled markedly, and can be extended.
[0076]
[Effect of the Invention] Like the above, according to this invention, when the source of heating which heats adsorption material at a playback process is lower temperature, it is usable, and the miniaturization of the equipment physique can offer easy adsorption equation heat pump at temperature with the higher source of cooling which cools adsorption material in an adsorption stroke.

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[Translation done.]

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## TECHNICAL FIELD

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[Field of the Invention] This invention relates to adsorption equation heat pump available to a refrigerator, a refrigerator, an air conditioner, etc.

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[Translation done.]

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## PRIOR ART

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[Description of the Prior Art] The adsorption material in which adsorption and desorption are possible, and adsorption material are filled up with a refrigerant steam, and the adsorption-equation heat pump which is used for various kinds of refrigerators, a refrigerator, an air conditioner, etc. has the structure where of the reaction container with which the adsorption and desorption of a refrigerant steam are performed, the evaporator which takes out to the exterior the cold energy obtained by evaporation of refrigerant liquid, and the condenser which emits the warm temperature obtained by condensation of a refrigerant steam to the exterior were mutually connected by piping, the bulb etc., respectively

[0003] the above-mentioned adsorption equation heat pump — setting — a refrigerant steam — the reaction container from an evaporator — moreover, while circulating from a reaction container to a condenser, a reaction container is heated or cooled by turns by the source of heating, and the source of cooling — having — this heating or cooling — responding — the adsorption material in a reaction container — a refrigerant steam — adsorption — or desorption is carried out. This serves as adsorption or a playback process.

[0004] By adsorption equation heat pump, adsorption-and-desorption difference-of-quantity deltaX (=Xa-Xd) which is generally the difference of the refrigerant steamy amount of adsorption Xa in an adsorption stroke and the refrigerant steamy amount of adsorption Xd in a playback process serves as a source of a thermal output. The refrigerant steamy amount of adsorption is determined by relative vapor pressure P/Po which is the ratio of the saturation pressure Po of the refrigerant steam corresponding to the temperature of adsorption material, and the pressure P of the refrigerant steam in a system (for example, evaporator).

[0005] so that whenever [ adsorption material temperature / which increases, so that whenever / adsorption material temperature / which Xa has in an adsorption stroke / is low in adsorption equation heat pump (P/Po is size), and Xd has in a playback process ] is high — decreasing (P/Po being smallness) — if it is not Xa>Xd, adsorption equation heat pump will not function. That is, since it is heated or cooled by the source of heating, and the source of cooling, adsorption material needs for the temperature gradient of the source of heating and the source of cooling to be large to some extent for actuation of adsorption equation heat pump.

[0006] He was trying for temperature required for a playback process not to become not much high by the conventional adsorption equation heat pump by lowering the temperature of an adsorption stroke, using low-temperature cooling water (30 degrees C or less) as a source of cooling. Thereby, low-temperature waste heat etc. can be used now as a source of heating of a playback process. Or the cooling water which is an elevated temperature beyond the temperature (about 30 degrees C) acquired in a cooling tower can be used now by raising the temperature of a playback process, using an elevated-temperature heat source (80 degrees C or more) as a source of heating.

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[Translation done.]

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## EFFECT OF THE INVENTION

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[Effect of the Invention] Like the above, according to this invention, when the source of heating which heats adsorption material at a playback process is lower temperature, it is usable, and the miniaturization of the equipment physique can offer easy adsorption equation heat pump at temperature with the higher source of cooling which cools adsorption material in an adsorption stroke.

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[Translation done.]

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## TECHNICAL PROBLEM

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[Problem(s) to be Solved] However, there are the following troubles in the conventional adsorption equation heat pump. In adsorption equation heat pump, when the about 30-degree C cooling water obtained by the cooling tower etc. is used as a source of cooling, in order to obtain 10-degree C cold energy, the source of heating 70 degrees C or more is needed.
[0008] It was very difficult for using a cooling tower to secure 30-degree C low-temperature cooling water by air-conditioners for mount, such as difficult home use and an automobile, at summer (environmental condition from which an OAT becomes about 35 degrees C). Furthermore, when the temperature of cooling water becomes about 40 degrees C, the hot source of heating 95 degrees C or more is needed. Such a source of heating had the problem that it was unrealizable unless it uses heating means, such as a boiler. For this reason, it was difficult to be easy to enlarge equipment and to use as an air conditioner for home use and mount.
[0009] By the way, the method of realizing the playback process of adsorption equation heat pump using the low-temperature source of heating more is indicated by JP,5-248727,A. Here, the adsorption equation heat pump which connected and constituted two steps of adsorption towers (reaction container) in the serial between the evaporator and the condenser is indicated. This heat pump is characterized by conveying the refrigerant steam to which it stuck in the 1st step of adsorption tower (reaction container) using the difference of the 1st step of desorption equilibrium pressure, and adsorption [ the 2nd step of ] equilibrium pressure to the 2nd step of adsorption tower (reaction container) which the playback process ended.
[0010] The above-mentioned adsorption equation heat pump can obtain 10-degree C cold energy by using the about 50-degree C source of heating, when about 30-degree C cooling water is used as a source of cooling. Moreover, in the above-mentioned conventional technique, the 30-degree C source of cooling in summer uses a cooling tower (cooling tower), and the 50-degree C source of heating supposes that exhaust heat of works, a thermal power station, etc. can be used.
[0011] However, as adsorption equation heat pump with which the application of the air-conditioner for mount etc. is still provided from a cooling tower etc. being required also in the above-mentioned conventional technique, it is inadequate. Furthermore, in the above-mentioned conventional technique, since adsorption equation heat pump is operated in the field where change of the equilibrium pressure to the refrigerant steamy amount of adsorption is large when the circulating water temperature used as the source of cooling is high, in order to secure enough the adsorption-and-desorption difference of quantity of a refrigerant steam, temperature of the source of heating needed to be made high. For this reason, although the source of heating could be made into 50 degrees C under the condition from which the source of cooling becomes 30 degrees C, for example, when the source of cooling is made into 40 degrees C, in order to secure identity ability, the source of heating needed to be made into 80 degrees C or more.
[0012] The source of heating of this invention which heats adsorption material at a playback process when the source of cooling which cools adsorption material in an adsorption stroke in view of this trouble is higher temperature is usable at lower temperature, and the miniaturization of the equipment physique tends to offer easy adsorption equation heat pump.

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[Translation done.]

## MEANS

[Means for Solving the Problem] The reaction container which the adsorption material in which adsorption and desorption are possible, and adsorption material are filled up with a refrigerant steam to invention of claim 1, and transmits the heat of reaction by the adsorption and desorption of a refrigerant steam to a heat carrier, The evaporator which takes out to the exterior the cold energy obtained by evaporation of refrigerant liquid, and the condenser which radiates heat to the exterior in the warm temperature obtained by condensation of a refrigerant steam, It consists of a refrigerant steamy gas compressor which performs pressure-up transportation of a refrigerant steam, and this refrigerant steamy gas compressor is in the adsorption equation heat pump characterized by being constituted so that the above-mentioned reaction container in a playback process may be decompressed.
[0014] It explains below about an operation of this invention. In this invention, it is constituted so that the reaction container which has a refrigerant steamy gas compressor in a playback process may be decompressed. Therefore, it becomes movable [ the refrigerant steam from a reaction container ], and the playback process of a reaction container can be promoted more.
[0015] For this reason, the low-temperature source of heating and the hotter source of cooling are used more, and even if it is a case so that both temperature gradient may not function as adsorption equation heat pump by the former small, the adsorption equation heat pump concerning this invention can function. Moreover, since the low-temperature source of heating and the hotter source of cooling can be used more, a facility of a cooling tower, a boiler, etc. becomes unnecessary and the miniaturization of the equipment physique can be attained. Furthermore, since the cooling tower, the boiler, etc. are unnecessary, it becomes possible to use as home use and an air-conditioner for mount.
[0016] As mentioned above, according to this invention, at temperature with the higher source of cooling which cools adsorption material in an adsorption stroke, when the source of heating which heats adsorption material at a playback process is lower temperature, it is usable, and the miniaturization of the equipment physique can offer easy adsorption equation heat pump.
[0017] Next, it is desirable to arrange the reaction container filled up with adsorption material two or more vessels to between an evaporator and refrigerant steamy gas compressors (example of operation gestalt 2 reference). Thereby, a refrigerant steam is movable between reaction containers using the equilibrium-vapor-pressure difference of adsorption material. Thereby, desorption temperature can be made still lower. Moreover, the above-mentioned refrigerant steamy gas compressor can also be arranged between the reaction containers of two vessels.
[0018] Next, two or more kinds of adsorption material from which adsorption and desorption are possible for invention of claim 2 in a refrigerant steam, and an adsorption property differs, respectively, The reaction container which adsorption material with low adsorption equilibrium pressure and adsorption material with high adsorption equilibrium pressure are filled up with the same temperature conditions, respectively, and transmits the heat of reaction by the adsorption and desorption of a refrigerant steam to a heat carrier, By the evaporator which takes out to the exterior the cold energy obtained by evaporation of refrigerant liquid, and condensation of a refrigerant steam It consists of a condenser which radiates heat to the exterior in the obtained warm temperature, and is in the adsorption equation heat pump characterized by consisting of reaction containers with which it filled up with adsorption material with low adsorption equilibrium pressure so that a refrigerant steam may be transported to the reaction container with which it filled up with adsorption material with high adsorption equilibrium pressure (example of operation gestalt 3 reference).
[0019] It explains below about an operation of invention concerning this claim. The adsorption equation heat pump of this invention has the reaction container filled up with adsorption material with low adsorption equilibrium pressure, and the reaction container filled up with adsorption material with high adsorption equilibrium pressure, and it is constituted so that a refrigerant steam may be transported to the latter reaction container from the former reaction container. Therefore, while the adsorption in an elevated temperature becomes easy by the low adsorption material of adsorption equilibrium pressure and playback at low temperature becomes easy by the high adsorption material of adsorption equilibrium pressure, the playback process of low voltage adsorption material and the adsorption process of high-pressure adsorption material can be promoted more.
[0020] For this reason, the low-temperature source of heating and the hotter source of cooling are used more, and even if it is a case so that both temperature gradient may not function as adsorption equation heat pump by the former small, the adsorption equation heat pump concerning this invention can function. Moreover, since the low-temperature source of heating and the hotter source of cooling can be used more, a facility of a cooling tower, a boiler, etc. becomes unnecessary and the miniaturization of the equipment physique can be attained. Furthermore, since the cooling tower, the boiler, etc. are unnecessary, it becomes possible to use as home use and an air-conditioner for mount. An available reaction field (adsorption-and-desorption difference of quantity of a refrigerant steam) is sharply expandable by using two more or more kinds of adsorption material.
[0021] As mentioned above, according to this invention, at temperature with the higher source of cooling which cools adsorption material in an adsorption stroke, when the source of heating which heats adsorption material at a playback process is lower temperature, it is usable, and the miniaturization of the equipment physique can offer easy adsorption equation heat pump.
[0022] Next, the reaction container which adsorption and desorption are possible, and adsorption material with low adsorption equilibrium pressure and adsorption material with high adsorption equilibrium pressure are filled up with the same temperature conditions in a refrigerant steam, respectively, and transmits the heat of reaction by the adsorption and desorption of a refrigerant steam to a heat carrier, When heat is radiated to the exterior, the evaporator which

takes out to the exterior the cold energy obtained by evaporation of refrigerant liquid, and the warm temperature obtained by condensation of a refrigerant steam A condenser, It is desirable to consist of reaction containers with which it consisted of a refrigerant steamy gas compressor which performs pressure-up transportation of a refrigerant steam, and filled up with adsorption material with low adsorption equilibrium pressure so that a refrigerant steam may be transported to the reaction container with which it filled up with adsorption material with high adsorption equilibrium pressure (example of operation gestalt 4 reference).
[0023] In this case, since it is constituted so that the reaction container which has a refrigerant steamy gas compressor in a playback process may be decompressed, it becomes movable [ the refrigerant steam from a reaction container ], and the playback process of a reaction container can be promoted more. Moreover, by combining the low adsorption material of adsorption equilibrium pressure, and the high adsorption material of adsorption equilibrium pressure on the same temperature conditions, even when whenever [ in an adsorption stroke / adsorption material temperature ] is high, a refrigerant steam can be adsorbed easily, and an elevated-temperature heat source is not needed in a playback process, but an available reaction field (adsorption-and-desorption difference of quantity of a refrigerant steam) can be sharply expanded by using two more or more kinds of adsorption material.
[0024]
[Embodiment of the Invention] It explains using drawing 1 - drawing 3 about the adsorption equation heat pump concerning the example of an operation gestalt of example of operation gestalt 1 this invention. As shown in drawing 1 , the adsorption equation heat pump 1 of this example The reaction containers 11 and 12 which the adsorption material in which adsorption and desorption are possible, and adsorption material are filled up with a refrigerant steam, and transmit the heat of reaction by the adsorption and desorption of a refrigerant steam to a heat carrier, The evaporator 13 which takes out to the exterior the cold energy obtained by evaporation of refrigerant liquid, and the condenser 14 which radiates heat to the exterior in the warm temperature obtained by condensation of a refrigerant steam, It consists of a refrigerant steamy gas compressor 10 which performs pressure-up transportation of a refrigerant steam, and this refrigerant steamy gas compressor 10 is constituted so that the above-mentioned reaction containers 11 and 12 in a playback process may be decompressed.
[0025] Next, the adsorption equation heat pump 1 concerning this example is explained to a detail. As shown in drawing 1 , the reaction containers 11 and 12 with which it filled up with adsorption material are mutually connected by the refrigerant steam line 100, and the control bulbs 101-104 are formed in this refrigerant steam line 100.
[0026] Moreover, the evaporator 13 is connected to the refrigerant steam line 100. Moreover, the condenser 14 is connected to the refrigerant steam line 100 through the refrigerant steamy gas compressor 10. Moreover, the reaction containers 11 and 12 are connected to juxtaposition between the evaporator 13 and the condenser 14. Moreover, between the condenser 14 and the evaporator 13, the return piping 15 for returning the refrigerant liquid condensed with the condenser to an evaporator 13 is formed. In addition, the inlet port of the cold water with which a sign 131 serves as an air conditioning output from an evaporator 13, and a sign 141 are the inlet ports of the cooling water to a condenser 14. A sign 132,142 is the outlet of cold water and each cooling water. Moreover, the indoor space (air-conditioning space) which is not illustrated, the interior unit arranged possible [ heat exchange ], and the pump which circulates through cold water are connected to the cold-water piping 131,132.
[0027] Moreover, the thermal piping 17 is connected to the reaction container 11, the thermal piping 18 is connected to the reaction container 12, respectively, it changes to these thermal piping 17 and 18, and bulbs 175,176 and 185,186 are formed. Moreover, the heat carrier used as the source of heating for the thermal piping 17 and 18 to heat or cool the reaction container 11 and the adsorption material in 12 or the source of cooling is circulating. The heat carriers of this example are warm water (70 degrees C) and cooling water (40 degrees C).
[0028] Warm water is introduced from an inlet port 173,183 by closing motion of the change bulb 175,176,185,186, passes each reaction containers 11 and 12, and is drawn from an outlet 174,184. Cooling water is also introduced from an inlet port 171,181 by closing motion of the same change bulb 175,176,185,186, passes each reaction containers 11 and 12, and is drawn from an outlet 172,182. Moreover, the open air which is not illustrated, the exterior unit arranged possible [ heat exchange ], the calorifier which generates warm water, and the pump which circulates through a heat carrier are connected to the thermal piping 17 and 18.
[0029] The above-mentioned reaction containers 11 and 12 are filled up with the silica gel which is adsorption material. Moreover, pure water was used as the refrigerant liquid concerning this example, and a refrigerant steam. Moreover, as a heat carrier which acts as the source of heating to the reaction containers 11 and 12, and a source of cooling, the usual tap water (or brine [the antifreezing solution]) was used. In addition, the relation between relative vapor pressure P/Po which is the ratios of the saturation pressure Po of the steam corresponding to the steam amount of adsorption of the above-mentioned silica gel and the temperature of adsorption material and the pressure P of the steam in a reaction container was indicated to drawing 3 .
[0030] Actuation of the adsorption equation heat pump 1 concerning this example is explained. About by the 1st line, closing and the control bulb 102,103 were wide opened for the control bulb 101,104, and the adsorption stroke was performed for the playback process in the reaction container 12 in the reaction container 11. Moreover, the change bulb 175,176,185,186 is operated at this time, warm water was circulated to the thermal pipe 17, and cooling water was circulated to the thermal pipe 18.
[0031] The reaction container 12 is cooled by about 40 degrees C with the cooling water cooled by carrying out heat exchange to the open air. Moreover, the water in an evaporator 13 evaporates by open actuation of the control bulb 102, and it becomes a steam, and flows into the reaction container 12, and adsorption material is adsorbed. Steam migration is performed by the difference of the maximum vapor tension in evaporation temperature, and the adsorption equilibrium pressure corresponding to [ whenever / adsorption material temperature ] 40 degrees C, and the cold energy corresponding to evaporation temperature, i.e., an air conditioning output, is obtained in an evaporator 13. Since the cold water which flows an evaporator 13 serves as an air conditioning output, evaporation temperature lower than inlet-port cold-water temperature needs this cold water to be cooled. The temperature at this time is evaporation temperature, and operation was performed at the evaporation temperature of 10 degrees C in this example.
[0032] Although the reaction container 11 in a playback process is heated with 70-degree C warm water and it becomes the desorption equilibrium pressure corresponding to 70 degrees C, since maximum vapor tension with a condensation temperature [ of a condenser 14 ] of 40 degrees C (this [ abbreviation's ] being in the temperature of the cooling water which has cooled the condenser by carrying out) is higher than the desorption equilibrium pressure in 70 degrees C, the way things stand, migration of a steam is not performed.

 

[0033] Then, the refrigerant steamy gas compressor 10 is operated in parallel with open actuation of the above-mentioned control bulb 104. The refrigerant steamy gas compressor 10 can carry out the pressure up of the steam inhaled from the reaction container 11, and can carry out it to more than maximum vapor tension with a condensation temperature of 40 degrees C. It becomes movable [ a steam ] from the reaction container 11 to a condenser 14, and the playback process of the reaction container 11 is performed. A steam is condensed with a condenser 14 and it becomes water. Water is returned to an evaporator 13 with the return tubing 15. The above is about the 1st line.
[0034] About in the following line [ 2nd ], the reaction container 11 can obtain cold energy, i.e., an air conditioning output, from an evaporator 13 similarly by changing the control bulbs 101-104 and the change bulb 175,185,176,186 so that an adsorption stroke and the reaction container 12 may serve as a playback process. Continuous running of the adsorption equation heat pump 1 was performed by changing the 1st of a more than, and about the 2nd line one by one.

[0035] Next, an operating state is explained with the cycle Fig. of the adsorption equation heat pump 1. The line of the adsorption material equilibrium pressure which showed the relation of the water vapor pressure and the steam amount of adsorption in the temperature of 40 degrees C, 70 degrees C, and 95 degrees C is indicated by drawing 2 . Moreover, the pressure of (4)' in this drawing is equal to the maximum vapor tension of the water in the temperature of 40 degrees C. The cycle concerning (1) ->(2) ->(3) -> (4) indicated as the continuous line in this drawing is the adsorption equation heat pump concerning this example.
[0036] The reaction container 12 which desorption finished with the last process is in the condition of (4), and is cooled to the condition of (1) with cooling water in advance of a change in an adsorption stroke. Steam adsorption is started from an evaporator 13 by open actuation of the control bulb 102, and (2) HE amount of adsorption increases. The reaction container 11 which adsorption completed at the last process is in the condition of (2), and a temperature up is carried out to the condition of (3) with warm water in advance of a change at a playback process. By open actuation of the control bulb 103 and operation of the refrigerant steamy gas compressor 10, adsorption material equilibrium pressure extent obtained by (4) decompresses, the amount of adsorption decreases to the condition of (4), and desorption completes the reaction container 11. The pressure up of the steam is carried out from (4) to (5) by the refrigerant steamy gas compressor, and it is sent to a condenser 14. It condenses here and becomes water. This water is returned to an evaporator 13 with the return tubing 15.
[0037] Moreover, although it was the completely same structure as the adsorption equation heat pump applied to this example at drawing 2 , the broken line indicated the cycle of the thing of structure conventionally without a refrigerant steamy gas compressor. this cycle -- (1) ->(2) -> (3) -- it is '-> (4)'. As found in this drawing, in order to obtain conventionally the same engine performance (steam adsorption-and-desorption difference of quantity) as what performs operation at 40 degrees C and the evaporation temperature of 10 degrees C, and starts this example further in the adsorption material in an adsorption stroke from the heat pump of structure like the adsorption equation heat pump 1 concerning this example, it turned out that the adsorption material in a playback process must be held at 95 degrees C or more.
[0038] The warm water used as the source of heating for holding adsorption material at 95 degrees C or more is not obtained easily practically, and needs a facility of a boiler etc. Therefore, under the conditions from which low-temperature cooling water is not obtained, the operation itself was conventionally difficult for the adsorption equation heat pump of structure.
[0039] Next, it explains per [ in this example ] operation effectiveness. The adsorption equation heat pump concerning this example has the refrigerant steamy gas compressor 10, and this refrigerant steamy gas compressor 10 can carry out the pressure up of the steam inhaled from the reaction containers 11 and 12, and can carry out it to more than maximum vapor tension with a condensation temperature of 40 degrees C. It becomes movable [ a steam ] from the reaction containers 11 and 12 to a condenser 14, and the playback process of the reaction containers 11 and 12 is performed. When the adsorption material in an adsorption stroke is cooled at 40 degrees C and operation is performed at the evaporation temperature of 10 degrees C by this, even if the adsorption material in a playback process is about 70 degrees C, adsorption equation heat pump can be operated.
[0040] For this reason, installation of the cooling tower for obtaining low-temperature cooling water or hot warm water or a boiler becomes unnecessary, and an installation cost and a running cost can be reduced greatly. Moreover, it can consider as small and compact equipment from installation of a cooling tower, a boiler, etc. being unnecessary, and can consider as the equipment which can be installed in the narrow tooth space to which home use, the object for mount, etc. were restricted.
[0041] Therefore, according to this example, at temperature with the higher source of cooling which cools adsorption material in an adsorption stroke, when the source of heating which heats adsorption material at a playback process is lower temperature, it is usable, and the miniaturization of the equipment physique can offer easy adsorption equation heat pump.
[0042] In addition, by this example, although reduced pressure actuation of the reaction containers 11 and 12 was made to become 3 or less times with the compression ratio (a discharge pressure/suction pressure) of the refrigerant steamy gas compressor 10, under the service condition which does not pose a problem, the playback of enlargement of the refrigerant steamy gas compressor 10 or increase of consumption power at low temperature is still also attained by lowering suction pressure.
[0043] It explains using drawing 4 and drawing 5 per adsorption equation heat pump of the example of two examples of an operation gestalt. As shown in drawing 4 , the adsorption equation heat pump 2 concerning this example has the same configuration as the thing concerning drawing 1 of the example 1 of an operation gestalt. However, between the refrigerant steamy gas compressor 10 and the evaporator 13, the reaction container 211,212,221,222 which it has arranged at a time to the serial two vessels is formed.
[0044] Actuation of the adsorption equation heat pump 2 concerning this example is explained. About by the 1st line, closing and the control bulb 201,203,205 were wide opened for the control bulb 202,204,206, and the adsorption stroke was performed for the playback process in the reaction container 211,222 in the reaction container 212,221. Moreover, the change bulb 175,176,185,186 is operated at this time, 60-degree C warm water was circulated to the thermal pipe 17, and 40-degree C cooling water was circulated to the thermal pipe 18.
[0045] The reaction container 211 is cooled by about 40 degrees C with the cooling water cooled by carrying out heat exchange to the open air. Moreover, the water in an evaporator 13 evaporates by open actuation of the control bulb

201, and it becomes a steam, and flows into the reaction container 211, and adsorption material is adsorbed. Steam migration is performed by the difference of the maximum vapor tension in evaporation temperature, and the adsorption equilibrium pressure corresponding to [ whenever / adsorption material temperature ] 40 degrees C, and the cold energy corresponding to evaporation temperature, i.e., an air conditioning output, is obtained in an evaporator 13. Since the cold water which flows an evaporator 13 serves as an air conditioning output, evaporation temperature lower than inlet-port cold-water temperature needs this cold water to be cooled. In this example, operation was performed at the evaporation temperature of 10 degrees C.

[0046] Moreover, the reaction container 212,221 is heated with the 60-degree C warm water introduced into the thermal pipe 17, and a steam is desorbed from the adsorption material in a reaction container. The steam from the reaction container 221 flows into the reaction container 222 via the control bulb 203 opened wide, and this reaction container 222 is held at 40 degrees C in the 40-degree C heat carrier introduced into the thermal pipe 18. For this reason, adsorption of a steam is performed. And the steam desorbed from the reaction container 212 flows into a condenser 14 through the control bulb 205 opened wide. Although it is cooled and a steam serves as water here, this water is returned to an evaporator 13 with the return tubing 15.

[0047] Steam migration between the reaction containers 221,222 mentioned above is performed by differential pressure with a desorption equilibrium pressure [ of 60 degrees C ], and an adsorption equilibrium pressure of 40 degrees C. Moreover, steam migration to a condenser 14 from the reaction container 212 is performed by operating the refrigerant steamy gas compressor 10 in parallel with open actuation of the control bulb 205 like the example 1 of an operation gestalt.

[0048] About in the following line [ 2nd ], the reaction container 212,221 changes the control bulbs 201-206 and the change bulb 175,185,176,186 so that an adsorption stroke and the reaction container 211,222 may serve as a playback process. Thereby, cold energy can be similarly obtained from an evaporator 13. Continuous running of the adsorption equation heat pump 2 was performed by changing the 1st of a more than, and about the 2nd line one by one. Others are the same as that of the example 1 of an operation gestalt.

[0049] In addition, in this example, in the service condition from which hot warm water 70 degrees C or more is obtained, a bypass valve 29 is opened and operation of the refrigerant steamy gas compressor 10 is suspended, and it is constituted so that steam migration to the direct condenser 14 from the reaction container 222 can also be performed. In this case, the power consumption of the refrigerant steamy gas compressor 10 can be reduced.

[0050] Next, an operating state is explained with the cycle Fig. of the adsorption equation heat pump 2. The line of the adsorption material equilibrium pressure which showed the relation between the temperature of 40 degrees C, and the water vapor pressure and the steam amount of adsorption in 60 degrees C is indicated by drawing 5 . Moreover, the pressure of (9) in this drawing is equal to the maximum vapor tension of the water in the temperature of 40 degrees C. A white round head shows the cycle of the reaction container 211,221 by the side of an evaporator 13 among two cycles shown in this drawing, and the black dot shows the cycle of the reaction container 212,222. Moreover, adsorption stroke (4) ->(1) -> (2) of the reaction container 221 is the same as that of the example 1 of an operation gestalt.

[0051] The reaction container 211 which adsorption completed like the previous line is in the condition of (2), and a temperature up is carried out to (3) with warm water in advance of a change at a playback process. On the other hand, the reaction container 212 which desorption completed like the previous line is in the condition of (8), and is cooled to (5) with cooling water in advance of a change in an adsorption stroke.

[0052] Steam migration (arrow in drawing 5 ) by the differential pressure of (3) and (5) is performed by performing open actuation of the control bulb 206, as for the adsorption material of the reaction container 211, the amount of adsorption decreases from (3) to (4) (desorption carried out), the amount of adsorption increases to (6) from (5), and the adsorption material of the reaction container 212 serves as the completion of adsorption.

[0053] The reaction container 222 which adsorption completed like the previous line is reproduced with (6) ->(7) -> (8) by the same actuation as the example 1 of an operation gestalt, the pressure up of the steam is carried out to (9) from (8), and it is sent to a condenser 14. Others are the same as that of the example 1 of an operation gestalt.

[0054] The adsorption equation heat pump 2 of this example can offer the system with very high practical use value by which cooling water becomes available also under the environment which does not use a cooling tower like an air-conditioner for home use or the air-conditioner for automobiles from the ability to operate at the high temperature of 40 degrees C, for example. Furthermore, 60-degree C warm water can divert an engine cooling water in an automobile, and can divert it from these equipments at the home equipped with hot-water heating or warm water floor heating.

[0055] As shown in drawing 6 and drawing 7 , the example of three examples of an operation gestalt is the adsorption equation heat pump of the structure concerning drawing 4 of the example 2 of an operation gestalt, and is considered as the configuration which does not use a refrigerant steamy gas compressor. However, each of two reaction containers was filled up with the adsorption material from which a property differs as shown in drawing 6 . That is, one side (reaction container concerning the sign 211,221 concerning drawing 4 ) of the above-mentioned reaction container is filled up with the low adsorption material A of adsorption equilibrium pressure as shown in the continuous line A of drawing 6 . Another side (reaction container concerning the sign 212,222 concerning drawing 4 ) is filled up with the high adsorption material B of adsorption equilibrium pressure as shown in the continuous line B of drawing 6 .

[0056] As adsorption material of this example, the meso porous molecular sieve (FSM) currently indicated by JP,9-178292,A was suitable. Above FSM was doubled with the service temperature region, and it used it for this example, having improved in part.

[0057] Operation of the adsorption equation heat pump of this example can be performed like the example 2 of an operation gestalt. Although that detail is explained below, the sign concerning this explanation applies to drawing 4 correspondingly. That is, about by the 1st line, closing and the control bulb 201,203,205 were wide opened for the control bulb 202,204,206, and the adsorption stroke was performed for the playback process in the reaction container 211,222 in the reaction container 212,221. Moreover, it changes at this time and a bulb 175,176,185,186 is operated, 70-degree C warm water was circulated to the thermal pipe 17, and 40-degree C cooling water was circulated to the thermal pipe 18.

[0058] The reaction container 211 is cooled by about 40 degrees C with the cooling water cooled by carrying out heat exchange to the open air. Moreover, the water in an evaporator 13 evaporates by open actuation of the control bulb 201, and it becomes a steam, and flows into the reaction container 211, and adsorption material is adsorbed. Steam

migration is performed by the difference of the maximum vapor tension in evaporation temperature, and the adsorption equilibrium pressure corresponding to [ whenever / adsorption material temperature ] 40 degrees C, and the cold energy corresponding to evaporation temperature, i.e., an air conditioning output, is obtained in an evaporator 13. Since the cold water which flows an evaporator 13 serves as an air conditioning output, evaporation temperature lower than inlet-port cold-water temperature needs this cold water to be cooled. In this example, operation was performed at the evaporation temperature of 10 degrees C.
[0059] Moreover, the reaction container 212,221 is heated with the 70-degree C warm water introduced into the thermal pipe 17, and a steam is desorbed from the adsorption material in the reaction container 212,221. The steam from the reaction container 221 flows into the reaction container 222 via the control bulb 203 opened wide. The reaction container 222 is held in the heat carrier introduced into the thermal pipe 18 at 40 degrees C. For this reason, adsorption of a steam is performed. The steam desorbed from the reaction container 212 flows into a condenser 14 through the control bulb 205 opened wide. Although it is cooled and a steam serves as water here, this water is returned to an evaporator 13 with the return tubing 15.
[0060] Moreover, steam migration between the reaction containers 221,222 mentioned above is performed by differential pressure with a desorption equilibrium pressure [ of 70 degrees C ] (reaction container 221), and an adsorption equilibrium pressure (reaction container 222) of 40 degrees C. Moreover, since the desorption equilibrium pressure (reaction container 212) of 70 degrees C is more than the maximum vapor tension corresponding to the condensation temperature of 40 degrees C of a steam, the steam migration to a condenser 14 from the reaction container 212 is performing steam migration to the direct condenser 14.
[0061] About in the following line [ 2nd ], the reaction container 212,221 changes the control bulbs 201-206 and the change bulb 175,185,176,186 so that an adsorption stroke and the reaction container 211,222 may serve as a playback process. Thereby, cold energy can be similarly obtained from an evaporator 13. Continuous running of the adsorption equation heat pump 2 was performed by changing the 1st of a more than, and about the 2nd line one by one. Others are the same as that of the example 1 of an operation gestalt.
[0062] By the adsorption equation heat pump concerning this example, comparatively many steams can be adsorbed also under the conditions that a circulating water temperature is high, by using the low adsorption material A of adsorption equilibrium pressure for one side of a reaction container. Moreover, desorption of the steam can be carried out at comparatively low temperature by using the high adsorption material B of adsorption equilibrium pressure for the reaction container of another side. moreover, the conventional technique using the same adsorption material although the adsorption material A and the adsorption material B also need to take into consideration and select the steam migration between reaction containers — a ratio — BE — **** — since it is used combining the adsorption material of adsorption equilibrium pressure, steam migration between reaction containers can also be performed easily.
[0063] Drawing 7 is the cycle Fig. of the adsorption equation heat pump concerning this example. In addition, the line of the adsorption material equilibrium pressure which showed the temperature of 40 degrees C of each adsorption material A and B and the relation of the water vapor pressure and the steam amount of adsorption in 70 degrees C is indicated by drawing 7 . This was compared with the cycle Fig. by the conventional technique of drawing 8 .
[0064] The structure of the adsorption equation heat pump concerning drawing 8 is completely the same as the adsorption equation heat pump concerning this example. However, the reaction container is filled up with the same adsorption material. For this reason, when [ which was high ] the temperature of cooling water called it 40 degrees C, unless it used warm water 70 degrees C or more, steam adsorption-and-desorption difference of quantity could not be secured, but ** and regenerating temperature of 70 degrees C in which a system was not materialized compared.
[0065] Consequently, with the conventional technique, since the same adsorption material was used, only 0.04 g/g was able to secure steam adsorption-and-desorption difference of quantity. in addition — a steam — adsorption and desorption — difference of quantity — said — drawing — it can set — (— one —) - (— two —) — between — or — (— five —) - (— six —) — a difference — [— an axis of abscissa — a direction —] — from — it can read .
[0066] However, in the same evaluation conditions, about 0.13 g/g was [ steam adsorption-and-desorption difference of quantity ] securable by using different adsorption material like this example. That is, the very big value of 3 or so times of the conventional technique was able to be acquired. Therefore, it turned out that the same engine performance can be secured by the adsorption material of one third of amounts as compared with the adsorption equation heat pump concerning the conventional technique of drawing 8 , and the miniaturization of all equipment ** can be enabled.
[0067] By the above, since small and highly efficient adsorption equation heat pump is realizable according to this example, the application as the air-conditioner and the air-conditioner for automobiles for home use which have constraint in an installation etc. can offer very easy adsorption equation heat pump.
[0068] The example of four examples of an operation gestalt is the adsorption equation heat pump which filled up the example 3 of an operation gestalt with the low adsorption material A of the adsorption equilibrium pressure of a publication, and the high adsorption material B of adsorption equilibrium pressure to the adsorption equation heat pump applied to the example 2 of an operation gestalt as shown in drawing 9 . And the reaction container 211,221 concerning above-mentioned drawing 4 is filled up with the adsorption material A, and the reaction container 212,222 is filled up with the adsorption material B. Others are the same as that of the example 2 of an operation gestalt.
[0069] Moreover, although operation etc. is the same as that of the example 2 of an operation gestalt, a detail is explained below. In addition, in the following explanation, a sign applies to drawing 4 of the example 2 of an operation gestalt correspondingly. About by the 1st line, closing and the control bulb 201,203,205 were wide opened for the control bulb 202,204,206, and the adsorption stroke was performed for the playback process in the reaction container 211,222 in the reaction container 212,221. Moreover, the change bulb 175,176,185,186 is operated at this time, 60-degree C warm water was circulated to the thermal pipe 17, and 40-degree C cooling water was circulated to the thermal pipe 18.
[0070] The reaction container 211 is cooled by about 40 degrees C with the cooling water cooled by carrying out heat exchange to the open air. Moreover, the water in an evaporator 13 evaporates by open actuation of the control bulb 201, and it becomes a steam, and flows into the reaction container 211, and adsorption material is adsorbed. Steam migration is performed by the difference of the maximum vapor tension in evaporation temperature, and the adsorption equilibrium pressure corresponding to [ whenever / adsorption material temperature ] 40 degrees C, and the cold energy corresponding to evaporation temperature, i.e., an air conditioning output, is obtained in an evaporator 13. Since the cold water which flows an evaporator 13 serves as an air conditioning output, evaporation temperature lower than

inlet-port cold-water temperature needs this cold water to be cooled. In this example, operation was performed at the evaporation temperature of 10 degrees C.
[0071] Moreover, the reaction container 212,221 is heated with the 60-degree C warm water introduced into the thermal pipe 17, and a steam is desorbed from the adsorption material in a container. The steam from the reaction container 221 flows into the reaction container 222 via the control bulb 203 opened wide, and this reaction container 222 is held at 40 degrees C in the 40-degree C heat carrier introduced into the thermal pipe 18. Adsorption of a steam is performed with this reaction container 222. The steam desorbed from the reaction container 212 flows into a condenser 14 through the control bulb 205 opened wide. Although it is cooled and a steam serves as water here, this water is returned to an evaporator 13 with the return tubing 15.
[0072] Moreover, steam migration between the reaction containers 221,222 mentioned above is performed by differential pressure with a desorption equilibrium pressure [ of 60 degrees C ] (reaction container 221), and an adsorption equilibrium pressure (reaction container 222) of 40 degrees C. Moreover, steam migration to a condenser 14 from the reaction container 212 is performed by operating the refrigerant steamy gas compressor 10 in parallel with open actuation of the control bulb 205 like the example 1 of an operation gestalt.
[0073] About in the following line [ 2nd ], the reaction container 212,221 changes the control bulbs 201-206 and the change bulb 175,185,176,186 so that an adsorption stroke and the reaction container 211,222 may serve as a playback process. Thereby, cold energy can be similarly obtained from an evaporator 13. Continuous running of the adsorption equation heat pump 2 was performed by changing the 1st of a more than, and about the 2nd line one by one. Others are the same as that of the example 1 of an operation gestalt.
[0074] Drawing 9 is the cycle Fig. of the adsorption equation heat pump concerning this example. In addition, the line of the adsorption material equilibrium pressure which showed the temperature of 40 degrees C of each adsorption material A and B and the relation of the water vapor pressure and the steam amount of adsorption in 60 degrees C is indicated by drawing 9 . In addition, the detail of a cycle is the same as that of the example 2 of an operation gestalt. According to this drawing, the warm water of lower temperature can be used, securing sufficient quantity of a steam adsorption-and-desorption difference like the example 3 of an operation gestalt. Therefore, according to this example, adsorption equation heat pump with high engine performance from which large adsorption-and-desorption difference of quantity is obtained with 60-degree C warm water can be obtained.
[0075] In addition, in this example, the compression ratio of a refrigerant steamy gas compressor is operated as a 2 double less or equal, and reduction of consumption power can be aimed at more. Moreover, when the compression ratio of a refrigerant steamy gas compressor is enlarged more and it operates, operation as adsorption equation heat pump can be enabled for the temperature of warm water to be still lower. As mentioned above, the adsorption equation heat pump of this example is applicable as air conditioners, such as ordinary homes. thus, according to this example, the application place of adsorption equation heat pump can be boiled markedly, and can be extended.

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[Translation done.]

## DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The explanatory view showing the system configuration of the adsorption equation heat pump concerning the example 1 of an operation gestalt.
[Drawing 2] The cycle Fig. concerning the example 1 of an operation gestalt showing the operating state of the system of adsorption equation heat pump.
[Drawing 3] The adsorption isotherm Fig. showing the property of the adsorption material with which the reaction container was filled up concerning the example 1 of an operation gestalt.
[Drawing 4] The explanatory view showing the system configuration of the adsorption equation heat pump concerning the example 2 of an operation gestalt.
[Drawing 5] The cycle Fig. concerning the example 2 of an operation gestalt showing the operating state of the system of adsorption equation heat pump.
[Drawing 6] The adsorption isotherm Fig. concerning the example 3 of an operation gestalt showing the property of two kinds of adsorption material.
[Drawing 7] The cycle Fig. concerning the example 3 of an operation gestalt showing the operating state of the system of adsorption equation heat pump.
[Drawing 8] The cycle Fig. of the adsorption equation heat pump concerning the conventional technique at the time of operating on the same temperature conditions as the adsorption equation heat pump concerning the example 3 of an operation gestalt.
[Drawing 9] The cycle Fig. concerning the example 4 of an operation gestalt showing the operating state of the system of adsorption equation heat pump.
[Description of Notations]
1 2 ... Adsorption equation heat pump,
11 12 ... Reaction container,
13 ... an evaporator,
14 ... a condenser,

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[Translation done.]

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DRAWINGS

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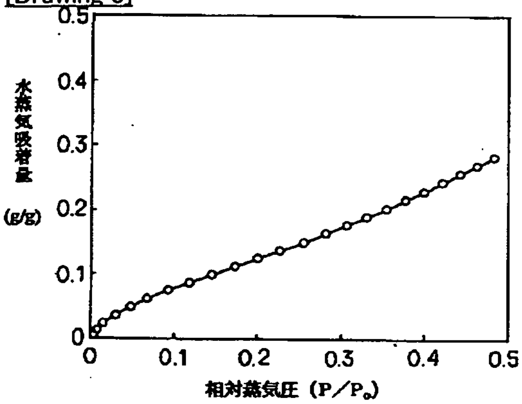
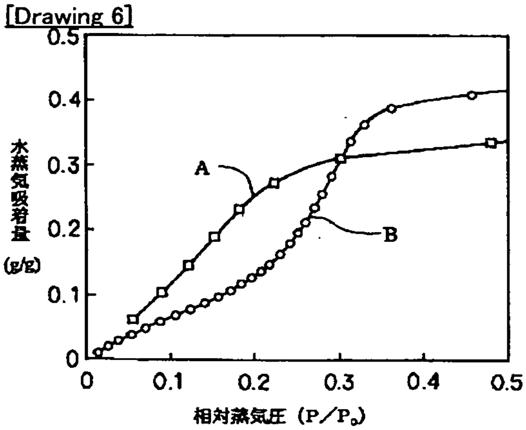
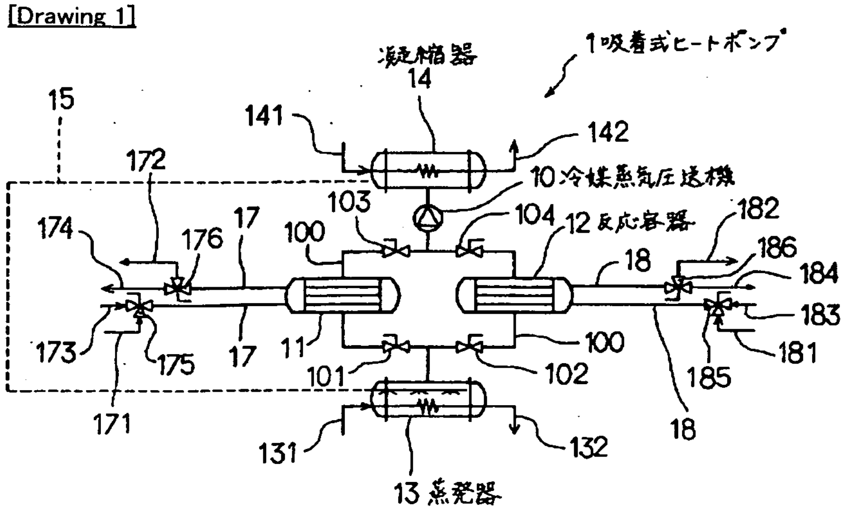
[Drawing 3]



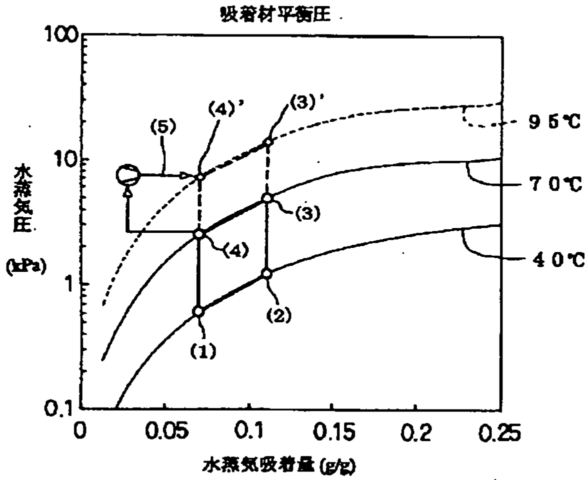

[Drawing 6]



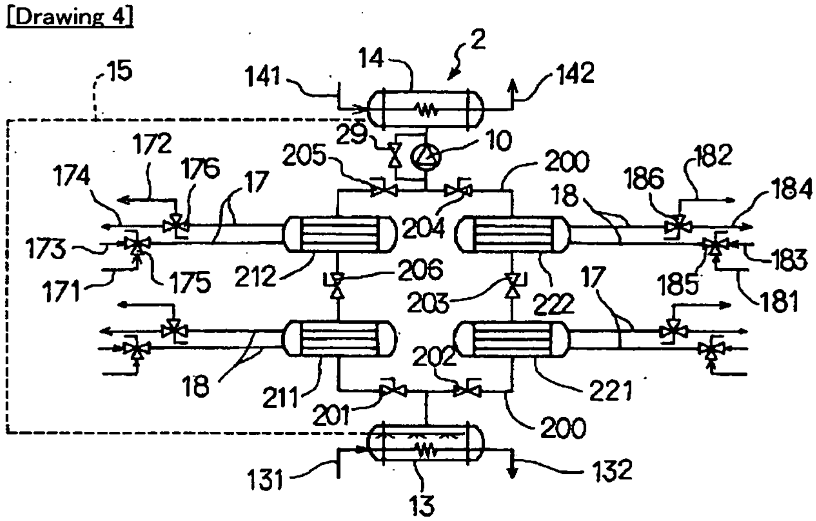

[Drawing 1]



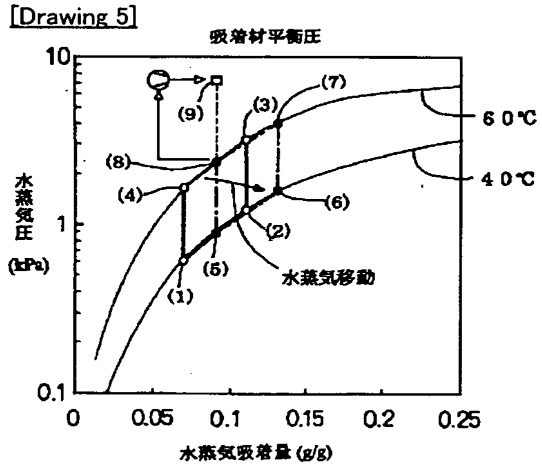

[Drawing 2]



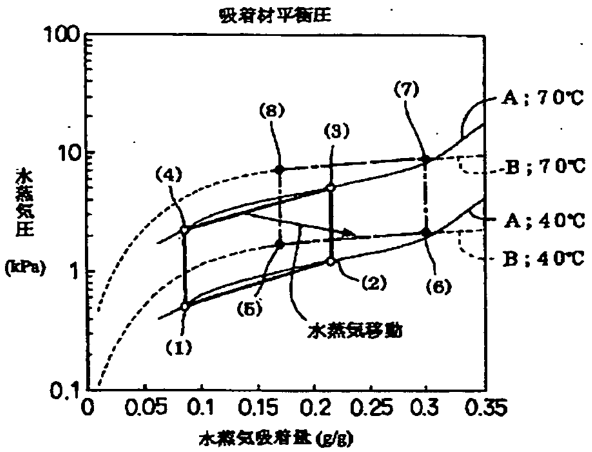

[Drawing 4]



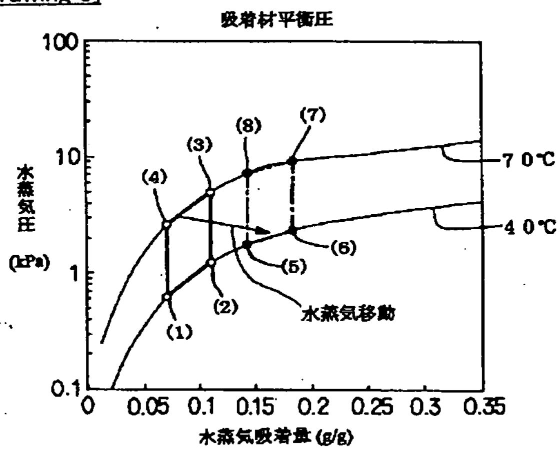
[Drawing 5]



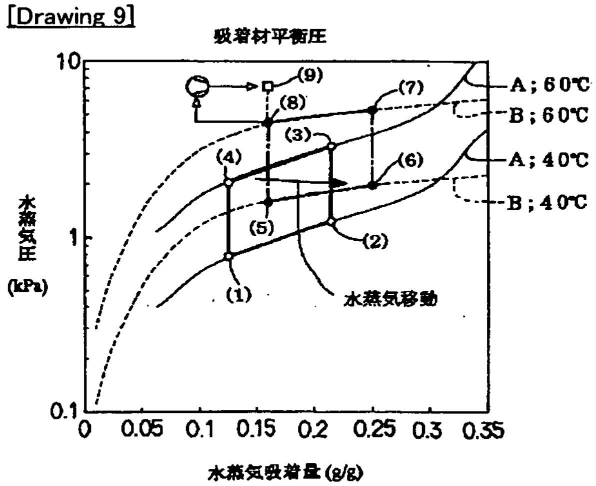

[Drawing 7]




[Drawing 8]




[Drawing 9]




[Translation done.]